THE EFFECTS OF AN INDIVIDUAL PRESCRIPTION DIET DURING PREGNANCY ON INFANT OUTCOME

by

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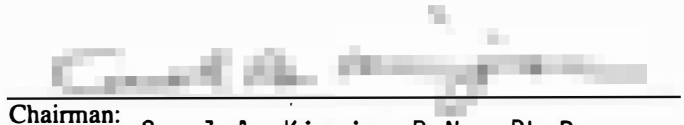

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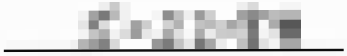

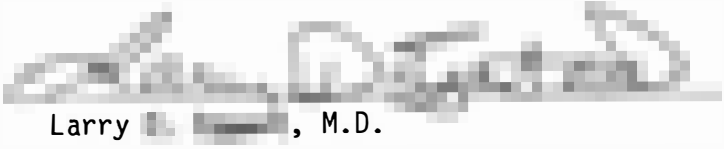

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ABSTRACT

The problem of this study was to identify the effects of an individual prenatal prescription for protein and kilocalorie requirements on subsequent infant outcome. This study, in part, replicated the Montreal Diet Dispensary prenatal dietary prescription program by Higgins. However, unlike the Higgins program, this project utilized a posttest-only control group design with random assignment of 29 subjects into groups. Additionally, food was not distributed in this study as in the Higgins study.

Results were analyzed between a group who received diet counseling and a group who did not receive counseling and a comparison was made between a group whose prenatal diet was adequate and one whose diet was inadequate. An adequate diet was considered to be an ingestion of both protein and kilocalories at greater than or equal to 85% of the individual prescription after the 20th week of gestation. A statistically significant difference in birthweight percentile was found between the adequate and inadequate diet groups. Two infants with jaundice requiring treatment were born to mothers from the inadequate diet group. Ponderal index was better for the infants in the adequate diet group compared with the inadequate diet group. The sample size was small and interfered with adequate analysis of the hypotheses. Power calculations indicated that a

Type II Error may have occurred in the analysis of birthweight and ponderal index.

CONTENTS

ACKNOWLEDGMENTS

There were many people instrumental in the completion of this thesis. My husband Jack helped me immensely with his emotional support and editorial help. My mother, Eleanor Blakely and my sister, Ellie Blakely, also deserve my thanks for their valuable assistance. I would also like to thank my children Michael, Jennifer, and Matthew for their patience. Lastly, but very importantly, I wish to thank Joyce Foster for her extraordinary assistance with advice, editing and computer work.

CHAPTER I

INTRODUCTION

The physical and mental developmental potential of newborn infants has been historically of great interest to mankind in general and women in particular. There has been a tacit assumption that maternal prenatal nutrition is essential to the health and development of the infant at birth and also later in life. However, there have been serious design deficiencies in research intended to quantitatively assess the association between the diet of the pregnant woman and the outcome of the pregnancy.

For example, some studies have failed to use a control group or used arbitrary instead of random assignments into groups (Higgins, 1975; Lechtig, Habicht, Delgado, Klein, Yarbrough & Martorell, 1975). Others failed to evaluate participant compliance to the prescribed intake or supplementation (Rush, Stein & Susser, 1980). Thus when the results of the study were analyzed, it was not clear which women actually took the supplement, or which women actually ingested the supplement but correspondingly decreased their regular dietary intake because of the supplement. Few studies to date have conducted extensive evaluation of the infants born to the women in these nutritional studies, using

presently available assessment standards and tools.

This present study is designed to overcome the above mentioned deficiencies. Design techniques that were used included random selection of participants into experimental and control groups. Serial evaluation of food intake during the last half of pregnancy was carried out. Bias was further reduced by the setting of double blind conditions for both the mothers in the study and the researcher. This report represents the newborn component of a randomized clinical trial of nutritional intake representing analysis of infant outcomes which followed and complemented the maternal outcome study.

Problem Statement

The specific problem of this study was to identify the effects of individual maternal prescriptions for protein and kilocalorie requirements during pregnancy on subsequent infant outcomes.

Purpose

The purpose of this research was to quantitatively describe the relationships between maternal nutritional status and infant outcomes. The study generated data from the comparison of infants born to women with adequate protein and kilocalories in their diets, with infants born to women without adequate protein and kilocalories in their diets. Methods of infant assessment which are dependent on maternal nutritional factors were defined and refined for quantitative analysis.

Design

The maternal researchers (Smith & Sweeney, 1983) randomly assigned pregnant women into experimental and control groups using a biased coin method to divide the sample into equal groups based on prepregnant weight and weight gain in the first 20 weeks of pregnancy (Egger, M., Personal Communication, March 18, 1982). Women in the experimental group were given a prescription for protein and kilocalorie intake based on their ideal weight, pregnancy needs and nutritional deficits according to the method devised by Higgins at the Montreal Diet Dispensary. They were then interviewed for a 7 day food intake recall every 2-4 weeks from the 20th week of pregnancy until delivery. Women in the control group had their diet prescription calculated but not shared with them. They were also interviewed for diet recall of food intake at the same intervals. However, they were not given any nutrition counseling. The newborn researcher was notified of the birth of the infants in the first few hours after birth. Both the newborn examiner and the mothers themselves were unaware of the group in which the participants belonged.

Assessment of the infants included physical and behavioral examination, anthropometric measurements, and review of the chart for laboratory data, medical diagnoses, and prescribed treatments for medical conditions.

Hypotheses

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher birthweight infants than infants born to mothers whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have decreased mortality compared to infants born to mothers whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have decreased morbidity compared to infants born to mothers whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will score more positively on the Early Parent Infant Relationship behavioral characteristic scale by Barnard, Blackburn, Kang and Spietz (1978) than infants born to mothers whose intake was less than 85% of their prescription (Barnard et al., 1978).

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have a higher ponderal index compared to

infants born to mothers whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher hematocrit laboratory values compared to infants born to women whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher dextrostix values compared to infants born to women whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have greater skin fold measurements than infants born to women whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have more positive results of their physical examination than infants born to women whose intake was less than 85% of their prescription.

Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher Apgar scores than infants born to women whose intake was less than 85% of their prescription.

CHAPTER II

LITERATURE REVIEW

When the first wave of excitement over learning about a pregnancy subsides, a woman often worries about the many details of her pregnancy. She may ask herself questions such as: How much weight should I gain? What types and amounts of foods should I eat? Are factors such as vitamins and minerals good or harmful to the baby that I am carrying?

Answers to her questions can come from several sources. These sources include common sense knowledge, advice from friends and relatives, books, and advice from health-care personnel such as her doctor and the nurse who teaches her prenatal class. What has been the history of prenatal nutrition education in this country?

Very little, if any, scientifically based dietary advice was given to pregnant women in the decades between the late 1800s and the turn of the century. Food choices during pregnancy were determined empirically and not by the results of scientific experiments of the role of nutrition during pregnancy (Worthington, Vermeersch & Williams, 1977). Foods were eaten if they were presumed to help the fetus. Much of the dietary advice from all sources was given to the pregnant woman based on emotional feelings associated with a certain food. For example, warm milk was believed to be beneficial to preg-

nant women because milk was thought to soothe the fetus. It was presumed to soothe the fetus because most people could see that newborns are quieted by warm milk. A conceptual carry over was made when milk was advised for pregnant women in hopes that the warm milk effect would eventually cause the same soothing reaction in the fetus.

During the era of the industrial revolution, nutritional status was poor for many individuals including pregnant women. The disease of rickets leading to the complication of a malformed pelvis in a pregnant woman created an obstetrical dilemma for the physician. Since a malformed pelvis precluded a safe delivery for a large infant and since surgical intervention in obstetrics was not commonplace, doctors attempted to keep the size of the infant low. Smaller babies could be delivered more easily in a woman with a malformed pelvis.

A physician, Prochownick, in about 1880 devised a special prenatal diet which helped women deliver smaller birthweight infants. His diet included fluid restriction, high protein, and a low carbohydrate plan. This diet was to be adhered to in the last 6 weeks of the pregnancy, and it did in fact, cause a significant rate of low birthweight babies to be delivered. The Prochownick diet was used extensively at a time around the late 1800s when there was a real need for lower birthweight babies to be delivered to rickets-ridden women. The condition of rickets induced malformation of the pelvis ceased being a common problem after the 1900s. However, the Prochownick diet continued to be used extensively. There is some belief that even today elements of the Prochownick diet can be seen in obstetrics (Worthington et al., 1977).

Weight restriction during pregnancy was continued by physicians during World War I and after 1914. Doctors in this era advised women to keep weight gain to between 10 to 14 pounds as a method of controlling toxemia. It was thought that if the prenatal weight gain was low, then the risk of toxemia would be low also (Ritchey & Taper, 1983).

After the 1940s, doctors were able to advise prenatal diets and recommended weight gains with the benefit of some nutritional studies dealing with pregnant women. Several experiments were conducted during the 1940s with the intent of experimentally determining whether there was a relationship between prenatal diets and maternal and infant outcomes. Maternal outcomes often examined in these experiments were mortality, toxemia, length of labor, length of hospital stay, and occurrence of hemorrhage. Infant outcomes frequently examined were mortality, prematurity, and illness in infants up to age 6 months.

Early Studies

The Leningrad Seige

From 1941 to early 1943 a political event occurred with severe health consequences to pregnant women and their offspring. This event was the seige of Leningrad by German soldiers. In a retrospective study by Antonov of Russia a total sample population of 3,630 births was described for a 2 year period. Some of the conditions of the population during this time were starvation, prolonged cold, no household heat, unusually high physical exertion, disease preva-

lence, and acute emotional stress. Newborn consequences to these conditions included increased mortality and morbidity, decreased birthweight, decreased vitality, as expressed in a general decrease in health, an increased incidence of erythema, and increased incidence of mammary gland swelling, an increased incidence of congenital softening of skull bones, and an increased incidence of prematurity. Some maternal effects to the seige conditions were alterations in lactation patterns including a decrease in milk production and shorter durations of total lactation, a decrease in the birth rate, and widespread amenorrhea. Doctor Antonov summarizes his report with the statement that "severe quantitative and qualitative hunger of the mother decidedly affects the development of the fetus and the vitality of the newborn child" (Antonov, 1946 p. 259).

The Ebbs, Tisdall, and Scott Study

Another important nutritional study was reported in the literature in 1941. In this study Ebbs, Tisdall, and Scott conducted a project with three groups of pregnant women. The three groups consisted of a poor diet group (N=120), a supplemented good diet group (N=90), and a good diet group (N=170). Within the sample the poor diet group was evenly matched with the supplemented good diet group for factors of age, amount of prenatal care, and income. The good diet group was not comparable to the other groups for number of primiparas and income, although for all other factors analyzed the good diet group was similar to the other two groups. The researchers concluded that maternal and infant outcomes were significantly improved

with food supplementation and dietary advice.

The Burke Study

The Burke study conducted at Harvard in 1943 was entitled "The Influence of Nutrition Upon the Condition of the Infant at Birth." The maternal sample of 216 pregnant women was individually interviewed for diet histories. Using the standards of the Recommended Dietary Allowances (RDA) the infants were given a pediatric rating of superior, good, fair, or poor. Obstetricians and pediatricians, oblivious to the nutritional ratings of the sample, then rated the mother's childbearing experience and the immediate infant condition respectively. Prenatal maternal diet ratings were then compared to the condition ratings of mothers and infants scored by the doctors.

The results of the study indicated a direct relationship between variables of the prenatal diet and the condition in mothers and infants. Generally, the Burke researchers determined that women who fell into the best prenatal diet rating groups also tended to fall into the best categories for maternal condition during and after labor and delivery. Furthermore, it was determined that women who were rated to have the best prenatal diets tended to deliver infants in better condition than women who did not eat well (Burke, Beal, Kirkwood & Stuart, 1943).

The Dutch Famine

Several studies, done in the 1940s found significant relationships between poor nutrition during pregnancy and low birthweight (Sindram, 1945; Smith, 1947; Stein, Susser & Saenger, 1975; Stroink,

1947). These writers studied the impact of a 6 month famine in Holland toward the end of World War II upon the surviving offspring of women pregnant during this disaster. A researcher today would not ethically be allowed to subject a population of pregnant women to such nutritionally deprived conditions. However, the researchers mentioned above turned the calamity of the Holland famine into scientific benefit through their careful investigation of the effects of the famine on newborns and later on these same individuals as adults. This retrospective and longitudinal study verified clinically the common sense knowledge that the diet of pregnant women can vitally affect the well being of their offspring.

The sample size examined was 40,000 with 80,000 subjects used as controls. Survivors of the famine were assessed for psychological effects, physical growth and development in the ensuing years. A clear relationship was established between poor prenatal nutrition and increased risks for fetal and infant problems. The researchers were able to quantitatively differentiate the infant effects to early and late prenatal malnutrition. Early prenatal malnutrition correlated with decreased fertility, increased central nervous system abnormalities, and symmetrical growth retardation. Late prenatal malnutrition was associated with decreased birthweight.

The research of the 1940s influenced many doctors in this country to give vitamin and mineral supplements, and encourage patients to receive diet counseling during pregnancy. However, medical schools have not included in depth study of nutrition as part of the standard curriculum, and so prenatal diet counseling varies from phy-

sician to physician.

The Vanderbilt Project

Results of another nutritional study, the Vanderbilt project, were published in 1954. This study involved a sample of about 2,300 pregnant women and their newborns. This was not a diet supplementation study, but instead an assessment of the nutritional state of the mother compared to maternal and infant outcomes during and after labor and delivery. The sample represented women who were caucasian, primarily married women who had received early prenatal care.

Nutritional assessment of the pregnant women included diet recalls and physical and laboratory findings. The sample overall was generally found to be well nourished. Findings of the research included 72 newborn deaths in the perinatal period, a 5.6% incidence of prematurity, and an acute toxemia rate of about 5%. None of these findings could be linked to diet or the nutritional status of the mother.

The large Vanderbilt study concluded that vitamins, minerals, and good nutritional status have little correlation with the maternal and infant outcomes of pregnancy if the mother enters her pregnancy well nourished. The Vanderbilt study involved women who were believed to be well nourished, and in this country doctors from the 1930s dealt for the most part also with well nourished women. Since the Vanderbilt study could not establish any relationship between prenatal nutrition and maternal and infant outcomes in a well nourished population, doctors from 1930 through the 1960s seemed less concerned about undernutrition creating problems in their patients

during or after pregnancy.

Obesity in pregnant women was a condition seen frequently by obstetricians from the 1930s. Obesity in pregnant women continues to be a problem even today. During the 1930s doctors prescribed weight gain restriction and sometimes even weight loss during pregnancy for obese women (Bingham, 1932). Obese pregnant women even today are frequently advised by their doctors to restrict weight gain to less than 15 pounds. For instance, in 1971 in a book written as a guide for future parents, a group of physicians from Boston Children's Medical Center recommended prenatal weight gains of less than 20 pounds. "To keep the weight gain in pregnancy under 20 pounds is a struggle for most women, but it is a necessary one" (Chasin, Chasin, Ehrlich, Feinblom, Gorbach, King, Mead, Newton & Wolff, 1971, p. 79).

Recent Prenatal Nutrition Studies

Literature, music, and the sciences have repeatedly depicted and dramatized woman as nurturing mothers during and after pregnancy. Scientific emphasis was represented when Freud focused on the enormous impact mothers have on the personality and lives of their children. Social anthropologist Sheila Kitzinger addressed motherhood and spoke of "an intensely powerful biologic bond which impels the mother to action to protect and cherish and feed her baby" (Kitzenger, 1978, p. 141). Pregnancy and nutrition seem to be themes that continually permeate our lives. Motherhood -- like patriotism -- represents values most Americans hold dear.

Prenatal nutrition and its subsequent effect on newborn health is a topic that has fascinated people throughout the ages. Perhaps the topic fascinates us because of our ability to identify with it. All of us were at one time nurtured in our mother's womb. We share this common bond with every human who has ever lived. We may also share the emotional feelings that are associated with nurturing or being nurtured by another human being. Health researchers carry this emotional bond with them when they attempt to scientifically examine the tremendous volume of studies involving prenatal nutrition and its effect on newborns.

The New York Study

One study involving nutrition for pregnant women and examination of their newborns was the 1972 New York study. This reseach scrutinized baby outcomes in women whose prenatal diet was supplemented or complemented for kilocalories and protein.

These newborns were compared to the controls or the group of babies whose pregnant mothers did not receive supplementation. The total population sample consisted of 768 women. This sample was subdivided into three groups:

1. a supplemented group receiving 40 grams of protein, 470 kilocalories, vitamins, and increased doses of minerals.
2. a complemented group receiving 6 grams of protein and 322 kilocalories, vitamins, and standard prenatal minerals.
3. a control group receiving standard vitamins and minerals.

The women all had incomes defined at the poverty level and possessed at least one of the following parameters: less than 110 pounds pre-

gravid weight, a past history of a low birthweight infant, a low weight gain determined at a prenatal visit, or less than 50 grams of protein dietary intake in 24 hours as determined from a diet interview.

The impetus for the New York study was the concern of researchers about the situation of black urban women giving birth to an alarming number of low birthweight newborns. Investigators assumed diet played a crucial role in the incidence of low birthweight infants.

A large sample size of N=250 was used in each group. Random assignment into groups was accomplished and a double blind modality was also utilized. Compliance to diet and supplement or complement was determined with 24 hour diet recalls and measurements of maternal weight gains.

The findings of the New York study were not anticipated by the researchers. Basically there was not a significant difference in birthweight when the supplemented, complemented, and control groups were contrasted. However, there was a higher rate of low birthweight newborns born to the supplemented group. This effect was unexplained. The newborns were followed and reassessed at age one year for anthropometrics, skinfolds, visual habituation, and mental and motor tests. The only positive conclusion from these batteries of tests was that the protein and kilocalorie supplemented group had better results for the factor of habituation. Criticisms of the study include inexact dietary assessments, varying amounts of calcium, zinc, copper, and magnesium in the two types of supplements,

and the failure of the researchers to control for the factors of smoking, age, parity, and short birth intervals (Hegsted, 1980; Rush, Stein & Susser, 1980; Susser, 1981).

The Bogota Study

The Bogota study, like the New York study, investigated urban malnourished women who had incomes defined at the poverty level. The Bogota study design and conclusions, however, were vastly different from the New York study. The sample consisted of 413 births and the design of the study was a prospective intervention of women's diets. The diet supplement consisted of 20 grams of protein and 136 kilocalories with actual foodstuffs used in the third trimester of pregnancy and also during the period of lactation.

Exact appraisal of the mother's intake was difficult to calculate due to the fact that the design of the study was one in which there was supplementation of the diet of the family. It was not possible to accurately determine what percent of the supplement the mother ingested.

The most important findings of this study were that male infant birthweights were increased, the incidence of low birthweight infants was reduced for the supplemented mothers and the supplemented infants habituated faster than the controls (Mora, de Paredes, Wagner, de Navarro, Suescun, Christiansen & Herrara, 1979).

The Guatemala Study

A prenatal supplementation study involving 1,536 pregnancies over 3 years was conducted in Guatemala. In the study two sup-

plements were used called fresco and atole. The fresco supplement had vitamins and minerals, minimal kilocalories, and no protein. The atole supplement contained vitamins and minerals, kilocalories, and protein. The sample population was drawn from four villages. The women from two of the villages received the atole supplement, while the women from the other two vilages received the fresco supplement. The women were all undernourished for kilocalories and protein at the beginning of the study.

The experimental approach was quasiexperimental due to the fact that the women could choose how much supplement to take and how often to drink it. Since the women were observed ingesting the supplement, there was good opportunity to calculate the specific amount of supplement taken by each women.

Major findings of the research included maternal effects in the supplemented group of better prenatal weight gain, increased placental weight, decreased postpartum amenorrhea, and decreased birth interval. Newborn effects in the infants born to the atole or good supplement group included increased birthweight, decreased mortality, and better performance in psychomotor areas. Comparison of individuals in the atole or good groups versus the fresco or control groups indicated that the kilocalories, not the protein, caused the favorable results (Habicht, Yarbrough, Lechtig & Klein, 1974; Lechtig, 1982; Lechtig, Martorell, Delgado, Yarbrough & Klein, 1978).

The Montreal Diet Dispensary Plan

Agnes Higgins of the Montreal Diet Dispensary conducted a long term diet supplementation program that coupled the delivery of actual foods plus in depth dietary advice to pregnant women. The sample size of the Higgins study was 1,213 women who were all believed to be undernourished and at high risk for delivering a small birthweight infant.

The supplement consisted of actual foodstuffs such as a quart of milk, eggs, and oranges. This use of common foods for the supplement instead of the use of canned beverages that would only be used in a research project was advantageous for several reasons.

A woman taking a canned supplement learns little about what foods are nutritious during and after pregnancy. But a woman who daily eats dairy and citrus products like the Higgins project participants, may over the time of the pregnancy, develop more positive dietary habits.

The individual treatment of the participants in the Montreal study sets this research apart from other prenatal supplementation programs. Not only were women given specific diet counseling based on their individualized preferences for foods, but also women were given other components of prenatal advice based on an individualized prescription for protein and kilocalories.

The Montreal diet dispensary approach to the treatment of diet counseling seems to be a custom made plan for optimal nutrition during pregnancy. Obviously this approach requires significant amounts of time between counselors and pregnant women. Perhaps sur-

prising is the finding that the method for interviewing and assessing women was streamlined and time efficient. Certainly this will occur only when the counselors are well motivated, trained, and prepared.

The most important result of the study was a 157 gram average birthweight increase in newborns born to women who received the supplement and the prenatal dietary counseling compared with nonstudy patients. However, a limitation of this study was the lack of a control group. Limited retrospective outcome data for infants was obtained from a comparison group of nonstudy patients delivering in the same hospital (Higgins, 1975; Higgins, Crampton & Moxley, 1972).

Summary

From the 1800s until the present time women have received contradictory or changing advice about prenatal diet and supplements. Advice about weight gain during pregnancy has ranged from no advice to counseling for weight loss or weight gains of 20 pounds or more. Vitamins and mineral supplementations have been recommended during some years and discouraged in other years. Women have assuredly received conflicting advice about nutrition during pregnancy for many valid reasons. Some reasons for the conflicting advice have included the difficulty in assessing maternal and newborn nutritional status, seemingly contradictory results from nutritional research with pregnant women, the influence of tradition in advice from physicians, and the changing standard of living and consequently the changing health status of women in this country since the 1800s.

CHAPTER III

METHODOLOGY

Design

A posttest-only control group design was used with randomly assigned subjects (Campbell & Stanley, 1963) (Figure 1.) Random selection of mothers into either the control or experimental groups was accomplished using the biased coin design. The biased coin design is an adaptive randomization scheme which permits approximate balancing of numbers of mothers in the treatment versus the control group. In contrast to systematic sampling, the biased coin design decreases the chances that certain women would be arranged into specific groups because of the bias of the researcher (Appendix A). Previous health studies have successfully utilized this method when subjects are accessioned into a study one by one over time (Efron, 1980; Hannigan & Brown, 1982). Random assignment to groups should reduce the threats to internal validity such as history, mortality, and selection between the experimental and control groups. Using a control group may also help decrease threats such as testing, instrumentation, regression, and maturation (Campbell et al., 1963).

(R)	prenatal nutritional counseling	newborn assessment
(R)		newborn assessment

Figure 1. Posttest-only control group design.

Sample

The sample of newborns was derived directly from the maternal sample. The following is a description of that sample which comes directly from the work of Smith and Sweeney (1983, p. 20).

> The study was designed to include all healthy, pregnant women receiving care at the University Medical Center during the specified study time periods. Study subjects were chosen from the Medical Center clinics, mainly Clinic III and Murray Clinic. Teenage patients being seen in the Teen Clinic were not included because of the special nutritional services provided to them which should have negated the study protocol.
>
> During the time period of March 1 to May 30, 1982 the University of Utah Medical Center obstetrical charts were reviewed on a weekly basis to identify potential study subjects. The specified time period for delivery was August 1 to October 15, 1982.
>
> The criteria established to include a woman into the sample were: a) the woman must be able to communicate in English, b) she must be free of existing medical conditions including diabetes, history of gestational diabetes, heart disease, renal disease, essential hypertension, or metabolic disorders, c) she must smoke no more than two packages of cigarettes a day, and d) she must consume less than two ounces of alcohol a day. If the woman's chart revealed that she was due to deliver in the specified time period and met these criteria, she was noted by the researchers to be a potential study subject.
>
> Twenty-nine pregnant women were followed for nutritional analy-

sis. All women had their individual nutritional prescriptions completed but only the experimental group was given this information. Fourteen of these women were given an individualized prescription diet for protein and kilocalories based on their nonpregnant requirements, an addition for pregnancy, and selected corrections as indicated for underweight, inadequate diets prior to the prescription, and certain nutritional stresses. Of this group, 11 gained greater than or equal to 10 pounds by 20 weeks and approximately 3 had not gained 10 pounds by 20 weeks.

Fifteen women served as controls. Eleven of them gained greater than or equal to 10 pounds by 20 weeks gestation and 4 had not gained 10 pounds. The control group did not receive individual prescription information or counseling. All women were seen at 2 to 4 week intervals when diet recalls for the previous 7 days were done for protein and kilocalorie intake (Figure 2).

The infants born to all the subjects studied were assessed in the first 48 hours for health status utilizing a number of standardized measures.

Analysis of Data

Previous studies have found few harmful effects of the Higgins diet, with the exception of the New York study, in which the methodology has been questioned. Thus, one is tempted to increase the chances of statistical significance artifically by using one-tailed *t* tests. In general, one-tailed tests of significance are rarely appropriate in the scientific literature. A balanced viewpoint considers the possibility a) that the Higgins diet may stress protein and

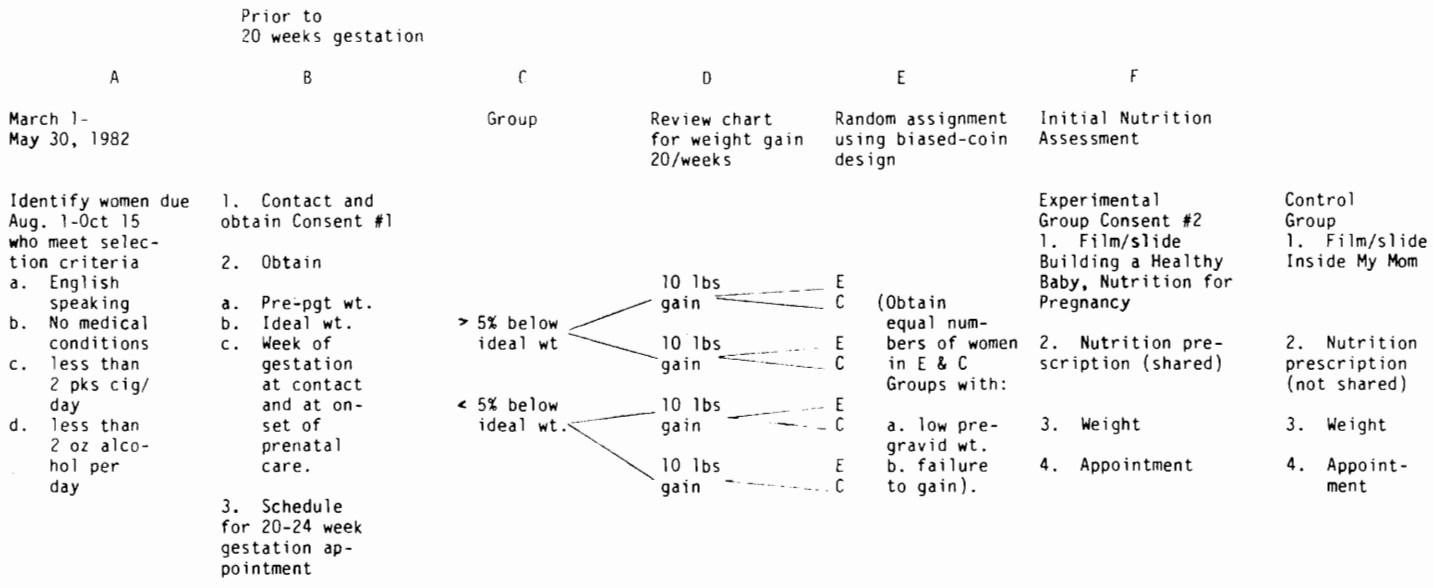


Figure 2. Research design and data flow chart.

20-40 weeks G		Delivery H	Outcome Data (All Subjects) I	
Experimental Group	Control	System of Checking for Deliveries and notify Researchers	Maternal	Perinatal
1. Chart Review	1. Chart Review		Nutritional Data	1. Gestational age
2. Q 3 weeks nutrition intake update	2. Q 3 weeks nutrition intake update		Protein/calorie prescription	2. Anthropometric
3. Weight	3. Weight		Weight gain Total Trimester	a. birth weight b. birth length c. head circumference d. chest circumference
4. Update prescription if necessary-counsel.	4. Answer specific nutrition questions and refer to health care provider for more info.		Weight gain plotted with intake	e. skinfolds arm circumference triceps skinfold subscapular skinfold
			Cooperative vs noncooperative	f. ponderal index
			% of Rx ingested Total Trimester	3. Laboratory hematocrit dextrostix
			Morbidity	4. Apgar score
			postdelivery weight placental weight fetal/placental weight ratio disease/conditions hematocrit spontaneous delivery	5. Behavioral assessment (Banard, Blackburn, Kang & Spitz, 1978). 6. Mortality and Morbidity
			Procedures	a. physical examination structural functional
			Induction Augmentation Forceps C-section	b. chart review for problems -respiratory complications -bilirubin complications

Figure 2 continued

calories to the exclusion of vitamins and minerals, b) that the Higgins prescription may produce very large babies with negative health effects, or c) that other unforseen disadvantages of the Higgins diet could occur, or d) that problems in the methodology could reduce infant health outcomes in the Higgins diet group. Thus, two-tailed *p*-values (which are twice the size of the one-tailed *p*-value, for small *p*-values) will be reported here.

Statistically nonsignificant results which appear marginal (*p* = .05-.10) were further assessed by power calculations to determine whether a clinically meaningful Type II Error is likely. Such Type II Error may occur when the sample size is too small for clinically meaningful results to be statistically significant.

Newborn Assessment Instruments and Procedures

The following instruments or data were used in the study in the total assessment of the newborns:

1. Gestational Age Assessment - the Farr method for dating newborns was used (1966). This method of calculating the gestation of infants utilized analysis of the anterior lens in newborns without palpable breast tissue (Farr, Kerridge & Mitchell, 1966).

2. Anthropometric Data -- (see Table 1).

3. Lab Values

    3.1. hematocrit (Ramamurthy & Brans Yves, 1981).

    3.2. dextrostix (Haworth, Dilling & Van Woert, 1972).

4. Apgar Score (Apgar, 1953)

    4.1. one minute assessment

Table 1

Anthropometric Data

Newborn measurement or calculations	Classification system for determining percentile ranking
1. birthweight	
a. preterm	Lubchenco, Hansman & Boyd (1966)
b. term	National Center for Health
c. postterm	Statistics Growth Charts (1976)
2. birth length	
a. preterm	Lubchenco et al. (1966)
b. term	National Center for Health
c. postterm	Statistics Growth Charts (1976)
3. head circumference	
a. preterm	Lubchenco et al. (1966)
b. term	National Center for Health
c. postterm	Statistics Growth Charts (1976)
4. chest circumference	Nelson, Vaughan & McKay (1969) chart
5. skin folds	
a. arm circumference	Ten-State Nutrition Survey
b. triceps skin fold	of 1968-1970
c. subscapular skin fold	(Appendix B)
6. ponderal index	Calculations without percentile ranking (Woods, Malan & de V Heese, 1979).

4.2. five minute assessment

5. Behavioral Assessment - the infant behavior assessment by Barnard, Blackburn, Kang, and Spietz (1978) was used (see Appendix C). From this infant behavior assessment a scoring system was developed by the researcher with assistance from Joyce C. Foster, CNM, Ph.D., and Carol A. Kirgis, R.N., Ph.D. of the University of Utah, College of Nursing.

4. Morbidity - (see Table 2)

The examination of the infant for the purpose of this study was noninvasive. The hematocrit and dextrostix data were taken from the chart since these tests are done by the University of Utah as part of the routine care of the newborn.

Definitions

Maternal nutrition was the independent variable. Conceptually it may be defined as the mothers' cellular nutrition level that is achieved as a direct result of her daily food intake.

Operationally, maternal nutrition may be defined as prenatal nutrition which is assessed by the diet recall system. Every 2 to 4 weeks the pregnant woman related her dietary intake during the past 7 days to the maternal nurse researcher. She also stated whether it differed from the 1 to 3 preceding weeks. Diets were analyzed for protein and kilocalorie intake. This enabled computation of average daily protein and kilocalorie intake for the last half of pregnancy. The dietary prescription for protein and kilocalories was calculated initially for each mother, but only women in the experimental group received the individualized prescription information. This dietary

Table 2

Morbidity

Category	Examples of Potential Problems
1. physical examination was completed using a local hospital guide.	
a. structural abnormalities	
skin	cyanosis
head	hydrocephaly
eyes	malformed eyes
ears	malformed ears
nose	choanal atresia
mouth	cleft lip/palate
neck	webbing
abdomen	prune belly, masses
extremities	syndactly; malformations
genitalia	hypospadias; chryptorchidism
anus	imperforate anus
spine	spina bifida
coccyx	meningomyelocele
b. functional abnormalities	
heart	murmur other than patent ductus arteriosus
respirations	apnea
cry	Cri du chat (high pitched abnormal cry) syndrome
femoral pulses	absent or decreased
reflexes	hypoactive response
motor activity	hyperactivity or lethargy
muscle tone	flaccidity or hypertonicity
red reflex	absent
neck (range of motion)	restricted

Table 2 Continued

Category	Examples of Potential Problems
2. chart review for specific complications and treatments.	
a. Respiratory complications:	
1. respiratory resuscitation in the delivery room	
2. respiratory resuscitation in the delivery room plus continuous positive airway pressure	
3. continuous positive airway pressure continued after the delivery room time	
4. respiratory resuscitation in the delivery room plus continuous positive airway pressure therapy after the delivery room time	
5. oxygen therapy in the first 24 hours	
6. oxygen therapy beyond 24 hours.	

prescription plan was developed by Higgins at the Montreal Diet Dispensary. This prescription takes into account each mother's individual qualities such as pregravid weight, ideal weight, and nonpregnant requirements based on ideal weight.

The dependent variable of the study was the health of the infant. Conceptually, newborn health status may be defined as a multiparameter analysis of cell nourishment in the infant, leading to health status and gestational maturity.

Operationally, infant health status may be defined as the indirect evaluation of cellular nourishment through a physical examination within the first 48 hours of life utilizing standard parameters of assessment.

The assessment of newborn behavior was accomplished using the Infant Behavior Assessment and Record by Barnard and associates (1978). The categories of behavior that were examined included the following behavior test definitions:

Categories of Behavior

1. Visual and auditory alerting
2. Readability
3. Motor behavior
4. Habituation
5. Smiling
6. Irritability
7. Consolability
8. Cuddliness.

All behaviors of infants were analyzed in light of the

state of the infant which ranged from awake to sleeping. The following states were recognized in newborns:

Behavior test definitions.

States

1. Deep Sleep
2. Light Sleep
3. Drowsy
4. Quiet alert
5. Active alert
6. Crying.

Assumptions

The following assumptions were made in this investigation:

1. It is possible to assess fetal nutritional status indirectly by assessing newborn health status directly.

2. There is a link between prenatal maternal nutrition and newborn health status.

3. Indirect measures such as behavioral tests will give some indication of fetal nutritional status.

4. The maternal prenatal to newborn correlation of nutrition may be expressed in a linear fashion.

5. Mothers can learn about and comply with individual diet prescriptions, and there will be perceptable effect in their newborns.

6. Health is both genetically and environmentally controlled.

In the following pages the newborn assessment instruments and procedures will be further discussed in relationship to the literature. Whenever there were several choices of instruments to use,

some discussion of options will be presented.

Determining Gestational Age in Newborns

The determination of gestational age is vital when assessing infants. The nutritional status of a 4,000 gram, 40-week gestation newborn may not be at all comparable to the nutritional status of a 4,000 gram, 36- week gestation newborn. A review of gestational age systems was conducted in order to determine which to use.

The University of Colorado Medical Center Classification of Newborns

The University of Colorado Medical Center Classification of Newborns categorizes newborns by weight and gestational age (Battaglia & Lubchenco, 1967). This system defines prematurity as less than 38 weeks gestation and postmaturity as greater than 41 weeks of gestation.

The Dubowitz and Finnstrom Methods

The Dubowitz and Finnstrom methods are used to determine gestational age based on normal neurological and physiological development (Latis, Semionato & Ferraris, 1981). Two studies have found that the 21 criteria Dubowitz method compares similarly with the seven criteria Finnstrom method for dating of infants (Latis et al., 1981; White, Fomofud & Rao, 1980). Since the Finnstrom method has only seven criteria, the method is simpler to accomplish than the Dubowitz. Accordingly, it takes less time to assess gestational age with

the Finnstrom method.

The Ballard Scoring System

The Ballard scoring system is another method for determining gestational age in the newborn. Six neuromuscular and six physical parameters are checked on the Ballard scoring form. Again, this is an easier method than the Dubowitz since there are fewer areas to check. One feature of the Ballard system is its appropriateness with the sick or well neonate due to the brevity of the test (Ballard, Kazmaier & Driver, 1977).

The review of the literature produced contradictions to this last point, however. Latis and associates state that the 12-criteria Ballard system is useful only with the well infant (Latis et al., 1980). When the Ballard and the Dubowitz systems are compared gestation age results are similar (Ballard et al., 1977; Korones & Lancaster, 1981).

Many of the methods for determining gestational age in newborns have the greatest reliability in the first 48 hours of the newborn's life. Since all the infants of this study were tested in the first 48 hours of life, the reliability factor should have been optimal.

The Robinson Test

The Robinson test for pupillary reaction to light is another test performed on premature infants in the attempt to determine the gestation stage of newborns. Pupillary action to light is absent in infants before 29 weeks gestation (Robinson, 1966).

The Farr Scoring System

The Farr scoring system was the method of determining gestational age in newborns that was finally selected for this study. Farr et al. (1966) devised a scoring system which evaluates plantar creases (there are five subcategories for plantar creases instead of the three to four subcategories of other systems), breast nodules, and ear firmness (the last categories are each divided into four subcategories). The Farr system has an additional component for assessment used only when no breast nodule is palpated. The additional component for these special infants without breast nodules (these infants' ages are less than 35 weeks of gestation) is opthalmoscopic examination of the anterior vascular capsule of the lens of the eyes. This eye examination can be accomplished without drugs or eyelid retractors.

The Farr system, used together with the eye examination, has many advantages. The advantages are that only four categories are checked; plantar creases, breast nodules, ear firmness, and sometimes eyes. Each of the categories is divided into clearly specified subcategories. The Farr method for determining gestational age in newborns takes less time to complete than the other methods since fewer areas are assessed. The most important advantage to the Farr method is that it can be performed reliably on well or sick newborns (Hittner, Hirsch & Rudolph, 1977; Narayanan, Dua, Gujral, Mehta, Mathew & Prabhakar, 1982).

Why is it believed that the Farr method can be performed more reliably on sick neonates compared to other methods of dating new-

borns? The reasons for this system having high marks for reliability are that the areas checked in the newborn assessment: plantar creases, breast nodules, ear firmness, and lenses are not subject to changes induced but illness. For example, some of the other tools for assessing gestational age such as the Dubowitz and Ballard methods utilize muscle tone evaluations which can be affected when acute illness such as respiratory distress is present. The Farr method uses no area for evaluation which would be altered as a result of illness.

Anthropometrics

The science of anthropometry can be appropriately directed toward newborns. In their first hours of life, newborns are weighed and measured in every conceivable manner not only by hospital nursing staff by also by pediatricians, medical and nursing students, and parents.

Newborn measurements can be categorized into two groups representing normal infants and abnormal infants. When newborns have measurements which fall at or below the fifth to tenth percentile category, these newborns are generally considered to constitute a high risk group for growth and development. For instance, a term newborn girl who weighs 2,268 grams and is 42.5 centimeters long would fall below the fifth percentile for these measurements. Infants like this could represent poorly nourished individuals, a focus of this research.

Conventionally, data gathered in this study included weight, body length, and head and chest measurements. These values were then

graphed and plotted on appropriate scales that take into account the age of the neonate or actual weeks of gestation and sex differences.

Preterm infants have their own classification for length, weight, and head circumference (scales and graphs are derived from Lubchenco, Hansman & Boyd, 1967). There is no distinction for sex differences in these values as both males and females share the same scale.

Term and postterm newborns can be classified on a different scale for weight, length, and head circumference. These groups of newborns are divided into separate classifications based on sex differences (National Center of Health Statistics Growth Charts, 1976).

All infants, whether preterm, term, or postterm, can be assessed for chest circumference by using the same table (Nelson et al., 1969). This table lists different values for males versus females for newborn chest circumference.

All of the anthropometric data can be calculated into results which yield valuable information on the growth and development of newborns. The analysis of these multiparameter data can be done in order to determine optimum human growth and development (Woods, Malan & de V. Heese, 1979).

Assessment of Protein and Fat Reserves From Skin Fold Measurements

The measurement of skinfold thicknesses in newborns with the use of a Lange caliper enables researchers to obtain values indicating fat and muscle masses. The amount of fat tissue an infant has is generally believed to be in direct relationship to the kilocalorie

reserve of that individual infant. Muscle mass values represent protein reserves and indicate the nutritional state of the newborn and his growth in size (Frisancho, 1974). Generally for a newborn, the better the muscle and fat mass, the greater the protein and kilocalorie reserve.

The amount of fat found under the skin can be estimated through the triceps and subscapular skin fold measurements. The procedure for obtaining a triceps skin fold measurement is found in Appendix D.

Measurements can place the infant into categories of less than 5% or greater than or equal to 5%. This categorization compares the poor protein and fat reserve group with the better nourished group.

The procedure for taking a subscapular skin fold measurement is to measure with the Lange caliper gauge the left side of the back directly under the scapula, wait three seconds, and then record the value. Repeat this procedure two more times. Find a mean subscapular value from the three values.

The tables used to estimate percentiles for tricep skin folds, arm circumferences, and the muscle calculations, group all children from birth to four months in one category (Appendix B). Little information is available relating to skin folds for the newborns as a single group. Researchers currently must use the same table values for a newborn as they do for a 4-month old infant. Infants grow dramatically in 4 months and it does not seem appropriate to use the same table values for both ages of infants.

Subscapular skin fold information from this study was tabulated along percentile rankings. This percentile ranking of subscapular

skin fold information will help researchers in the future to determine which newborns are high risk due to low percentages of fat tissue.

Ponderal Index

Ponderal index identifies infants with weight to length disproportions (Zlatnik, 1979). An advantage of this calculation is that the investigator may obtain a whole number which can be used effectively as a comparison against other parameters in order to establish or refute a relationship.

Ponderal index is equal to the weight in grams times 100, this quantity is then divided by length of the body in centimeters cubed.

$$\text{Ponderal Index} = \frac{\text{weight (in grams) X100}}{\text{(body length in centimeters)3}}$$

Body length is defined as crown to heel length. Normal ponderal index values for newborns equal 2.39 - 2.70. A ponderal index of less than 2.39 is in the small range. Low measurements correlate with problems of the newborn (Barness, 1981). Ponderal index is also a method of identifying the condition of malnutrition (Zlatnik, 1979).

Ponderal indexes have been calculated for infants when the issue of small, average, or large for gestational age is in question.

Lab Values

Hematocrit: Assessment of Volume of Packed Red Cells

The hematocrit test is used to indirectly determine iron levels in individuals (Silver, Kempe & Bruyn, 1980). Normal levels for newborns are 50-70% for heel samples and 45 - 65% for venous samples (Brans, Shannon & Ramamurthy, 1981). This laboratory test is routinely done on most patients in larger hospitals.

Abnormally high values indicate polycythemia which may lead to damage to vital organs such as the brain, kidneys, lungs, and intestines. Unusually low values may indicate diminished red blood cell volume, with subsequent reduction in the oxygen carrying capacity of the blood.

Blood Glucose

The determination of blood glucose levels in newborns has been recognized as an important assessment in order to recognize the abnormal conditions of hypoglycemia or hyperglycemia. The dextrostix test has been shown to be a reliable method for determining blood glucose values in the newborn when proper technique and equipment are used (Appendix E).

The definition of hypoglycemia is a blood glucose serum level that is less than or equal to 25 mg/dl - 35 mg/dl at birth. By 2 hours after birth a glucose serum level of 50 mg/dl is considered to be normal.

Hyperglycemia or a blood glucose level above 100 mg/dl of blood is associated with septicemia and diabetes (Korones et al., 1981;

Silver et al., 1980). Usher (1970) stated that hyperglycemia is frequently seen in malnourished newborns due to their inability to maintain or control blood glucose levels.

Many pediatricians suggest that infants with dextrostix values of less than 45 mg/dl at 1 to 2 hours after birth be further evaluated for the condition of hypoglycemia. Hypoglycemia has been associated with infants who are low birthweight and born to diabetic mothers. Since this study evaluated birthweight, including low birthweight, it is advantageous to know glucose levels of all newborns in order to assess the condition of hypoglycemia which may lead to muscular and neurological problems that could even result in death (Usher, 1970). This may further identify correlations between birthweight and hypoglycemia.

Infants in this study at the University of Utah Medical Center routinely have dextrostix tests in the first 2 hours after birth. The dextrostix tests were performed according to the guidelines described in Appendix E.

Apgar Score: Assessment of Immediate Newborn Status

The Apgar test was devised in 1953 by Virginia Apgar, M.D. as an objective measure of the newborn's physiologic responses. It was designed to quickly determine newborn health status and need for resuscitation at birth. A perfect score of 10 means that the newborn is breathing well, has a strong heart beat and cry, good skin color, and muscle tone. Poor scores of zero to six immediately alert the health care provider to the urgent needs of the baby for assistance in order

to support life.

The Apgar test is used throughout the nation as a universal system for measuring how intact the infant's crucial body systems are functioning. The value of the test has extended to some prediction of future problems from the newborn phase to the childhood phase of individuals. For example, fetal malnutrition has a high association with Apgar scores of less than four out of a possible total of ten according to Usher (1970). In 1979, Hardy, Drage, and Jackson showed an inverse relationship between Apgar test results five minutes after birth and neonatal mortality rates. This relationship was demonstrated earlier by another study (Drage & Berendes, 1966).

Apgar scores have not always been found to have a high confidence as predictors of neurological problems. Nelson and Ellenberg (1981) point out that in a group of 49,000 infants studied for seven years, 55% of children who later were diagnosed with cerebral palsy had high one and five minute Apgar scores. Poor Apgar scores could indicate many conditions such as prematurity, postmaturity, birth defects, asphyxia, and poor management of labor (Eggert, L.D., M.D. Personal communication, March 15, 1984).

There were some questions as illustrated by this brief literature discussion about the appropriateness of using Apgar test scores as predictors of newborn outcomes such as nutritional status. However, because the Apgar test is one of the only infant assessments that is consistently performed in all hospitals at 1 and 5 minutes after birth, and since this test has been shown to indicate some neurological problems in infants, the Apgar test was used in this

study.

Behavioral Examination

Another component of the complete newborn assessment is evaluation of behavior. Infant behavior evaluation can take the form of the systematic behavioral assessment by Brazelton (1973). In this system the examiner uses a scale with scores ranging from one to nine in order to assess behavior. In 1978, a March of Dimes funded study incorporated Brazelton's concepts into an abbreviated and easier to use version entitled "Early Parent Infant Relationships" (Barnard, Blackburn, Kang & Spietz, 1978). This tool assesses groups of behaviors in infants ranging from auditory and visual alerting, motor activity (both quality and quantity is observed), habituation or dampening of responses to environmental stimuli, irritability, consolability, readability, cuddliness, and smiling (Appendix C).

Behaviors in the assessment were state related. The newborn states are deep and light sleep, drowsy, quiet alert, active alert, and crying. Infants who were in deep sleep (an untestable state for checking smiling) were scored in such a way as to not detract from their total score for behavior. The scoring system developed with 100% as the perfect or most desirable score. An infant scoring 100% represented the most desirable behaviors (i.e., he or she was very alert, very consolable, and not irritable). Sick neonates who could not be tested for behaviors were specially designated.

Morbidity

Physical Examination

A complete physical examination of the newborn was necessary in order to determine infant health and nutritional status (Krehl, 1964).

One crucial part of the newborn assessment is the general physical examination. A physical examination form developed at a local hospital was used for this study (Appendix G). This form guided the newborn examiner in the head to toe general assessment of infants in the study. The items in the form were divided into structural and functional categories for the purposes of this study.

Mortality and Morbidity

The association between fetal malnutrition and increased newborn mortality and morbidity has been identified repeatedly in the past. Fetal malnutrition leading to low birthweight in newborns is strongly associated with a high death rate in these infants. For example, in newborns who are found to be 40% underweight for gestational age, there is a mortality rate of 543 per 1,000 births. This is an alarmingly high rate of mortality. These poorly nourished infants can be contrasted with another group of better nourished newborns. Mortality rates were studied for infants found less than 15% underweight. These babies when grouped together have a mortality rate of only 14 deaths per 1,000 births. The difference then between babies severely underweight versus minimally underweight is the ratio of 543/14 deaths per 1,000 births. Clearly, the nourishment of fetuses

must be a prime goal for health care providers if we wish to contribute to the decrease of infant mortality rates (Usher, 1970).

Research into the relationships between prenatal nutrition and neonatal mortality has been contradictory in the past. Some published nutrition studies recommended unrestricted prenatal weight gains while other studies recommended limiting prenatal weight gain to 15 pounds. For instance, Joseph Nathanson (1950) wrote about alarming high mortality rates of large infants when compared to average and small infants. Some obstetricians in the 1950s advised women to limit weight gain to about 15 pounds. A popular concept of the times was that the more weight the mother gained, the bigger her infant would be and subsequently the risk of infant mortality would be greater.

Animal studies have given some contradictory data on the subject of prenatal weight gain and infant mortality. However, many studies of animals yield impressively high mortality and morbidity statistics when malnutrition and corresponding low birthweight offspring result (Winick, 1970).

Prenatal malnutrition could be considered as strictly a problem related to prenatal weight gained or kilocalories needed and obtained. Another perspective to evaluating fetal malnourishment would be to determine the components of prenatal nourishment and then to analyze the effects of the components upon the health of the offspring. Winick, Brasel and Valeso (1973) elaborated on one type of morbidity alligned with an element of poor nutrition. Protein malnutrition in pregnant rats was examined by these researchers in

conjunction with infant cellular growth and development. They determined that when protein was inadequate in the prenatal diets of rats, that the infant rat brain cells were reduced by 15% and rat organ development was retarded.

An early study of prenatal nutrition and its effect on the newborn described infant birthweight, mortality, and morbidity as important factors when analyzing infant nutritional status (Ebbs, Tisdall & Scott, 1941). Others followed with a similar approach (Hillman, 1958; Iyengar, 1967; Mora et al., 1979; Pitkin, 1981; Susser, 1981; Tafari, Naeye & Gobezie, 1980).

Other researchers not only examined newborn weight, mortality, and morbidity, but also attempted to measure infant nutritional status as a reflection of behavioral and neurological achievements (Delgado et al., 1977; Ebbs, Tisdale & Scott, 1941; Moghissi, 1978; Singer, Westphal & Niswander, 1968; Vuori, Christiansen, Clement, Mora, Wagner & Herrera, 1979; Zlatnik, 1979).

Moghissi in 1978 assessed birthweight, cranial volume, motor and mental development. Singer measured weights, heights, motor and mental scores, and examined 8 and 12 month old infants neurologically. Delgado et al. (1977) assessed habituation, motor fitness, tremors, and startles. Vuori and associates (1979) measured visual habituation in the newborn. Stein, Susser, and Saenger (1975) wrote an in-depth study based on the Holland famine. Infant survivors from this nutritional disaster were followed through adulthood for mental status.

It can be seen from the multitude of tests available that infant

well-being is difficult to measure. Some studies used one, two, or three methods of evaluation. Other studies used multiple methods of evaluation. An optimum approach to newborn evaluation would seem to be the use of a set of methods, tests, and systems of infant analysis. Whenever possible, the most reliable method was chosen when several tests for the same criteria were available. Also, since several tests were performed on each infant, simpler, shorter tests were chosen over more complicated tests that take a long time and may have been exhausting to the newborn.

CHAPTER IV

RESULTS AND DISCUSSION

Newborn evaluations were conducted in the nurseries at the University of Utah Medical Center within 48 hours (preferably 24 hours) of birth. Resultant data were coded, keypunched onto cards and entered into the Univac 1100/61 Computer. Statistical analysis was carried out utilizing the STAT80 Program (Fullerton, 1982). Descriptive statistics were generated for all variables. Group means were compared using the HYPOTH test (two-tailed t tests).

Two-tailed tests to .1 are reported. Selected variables were correlated using the CORR procedure for Pearson Product Moment Correlations.

The Sample

All data were analyzed by dividing the sample into the four comparison groups of:

1. The adequate diet group - women who met their individual prescription for both protein and kilocalories at the 85% level or better.

2. The inadequate diet group - women who ate less than 85% of both their protein and kilocalorie prescription.

3. Experimental - women who reviewed counseling for their in-

dividual prescription for both protein and kilocalories.

4. Control - women who did not receive individual counseling concerning their prescription.

Originally the sample was divided into experimental and control groups using the biased coin method for random assignment of individuals into groups. Although it was anticipated that most of the individuals in the experimental group would meet their prescriptions for 85% of both protein and kilocalories, in fact some women in the experimental group did not eat adequately. Also some individuals in the control group actually did eat adequate diets. Since this study wsa concerned with the impact of adequate protein and kilocalories in prenatal diets, as well as the impact of the counseling sessions, it was necessary to divide the sample into the additional comparison groups.

The demographic variables of maternal age, marital status, ethnic background, education, income, occupation, and parity are presented in Tables 3 and 4. There was no significant difference in these variables between the four comparison groups. The mean maternal age for the total group of subjects was 22.8 years (S.D. 4.1) with a range of 17 to 34 years.

Maternal education for the total group was 13.1 years (S.D. 2.0) with a range of 9 to 18 years. Twenty-five of the 29 subjects were married and 4 were single. All participants were caucasian. Sixty-nine percent of the subjects had a total annual family income of less than $10,000. Only 14% had an income of greater than $20,000 per year.

Table 3

Comparison of Demographic Variables According to Intake and Group Assignment

	Adequate Diet N=13	Inadequate Diet N=15	P Value	Experimental N=14	Control N=15	P Value	Total N=29
	N=28[a]			N=29			
Age in years							
x̄	23.8	23.3		23.5	22.2	NS[b]	22.8
SD	4.7	3.5	NS	3.6	4.6		4.1
Range	19-34	17.28		19-32	17-34		17-34
Education years							
x̄	13.3	12.9		13.2	12.9	NS	13.1
SD	1.4	2.5		1.5	2.4		2.0
Range	12-16	9-18	NS	12-16	9-18		9-18

	Adequate Diet		Inadequate Diet		P Value	Experimental		Control		P Value	Total	
	No.	%	No.	%		No.	%	No.	%		No.	%
Marital Status												
Single	1	8	3	20	NS	1	7	3	20	NS	4	14
Married	12	92	12	80		13	93	12	80	NS	25	86
Race-Caucasian	13	100	15	100	NS	14	100	15	100	NS	29	100
Income												
$5,000/yr.	2	15	7	47	NS	3	21	6	40	NS	9	31
$5-9,999/yr.	7	54	3	20	NS	5	36	6	40	NS	11	38
$10-14,999/yr.	1	8	2	13	NS	2	14	1	6	NS	3	10
$15-19,999/yr.	1	8	1	7	NS	1	7	1	6	NS	2	7
$20,000/yr.	2	15	2	13	NS	3	21	1	6	NS	4	14
Occupation												
Operator	0	0	1	6.6	.058[c]	1	7	0	NS	NS	1	3
Craftsman	0	0	1	6.6		0	0	7	NS	NS	1	3
Salesman	0	0	1	6.6		0	0	13	NS	NS	2	7
Clerical	2	15	1	6.6		3	21	0	NS	NS	3	10
Professional	0	0	1	6.6		0	0	7	NS	NS	1	3
Homemaker	11	85	10	67		10	72	73	NS	NS	21	72

Note. [a]N=28 due to missing data; [b]not significant at $\alpha = .05$ (2-tailed test); [c]suggestive of significance.

Table 4

Comparison of Parity with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value	Total N=29	
	N=28[a]					N=29						
Parity												
x	1.4		1.2		NS[b]	1.3		1.3		NS	1.24	
SD	1.8		.94			1.2		1.6			1.4	
Range	0-6		0-3			0-4		0-6			0-6	
	N	%	N	%		N	%	N	%		N	%
Parity												
Nulli-para	5	39	4	27	NS	4	29	6	40	NS	10	35
Multi-para	8	61	11	73		10	71	9	60		19	65

Note. [a] N=28 due to missing data; [b] not significant at α = .05 (2-tailed test).

Descriptors for the study also included factors relating to the maternal obstetrical history. These factors were previous abortions, previous stillbirths, previous maternal and newborn complications and low birthweight infants (less than 3,000 grams). There were no significant differences between groups for these factors as presented in Table 5.

The personal health hazards of alcohol and cigarettes were calculated. This material is presented in Table 6. There were no significant differences between groups for alcohol consumption or cigarette usage.

When the groups were compared for participation in the WIC (Women, Infants, and Children Nutrition Program), no significant differences were found. Table 7 lists the WIC data for all groups.

There was no significant difference between the experimental and control groups in the anthropometric measures of height, prepregnant weight, ponderal index and ideal weight. Nor was there a difference between the adequate and inadequate intake groups in maternal height and ideal weight.

However, the adequate and inadequate groups were found to be dissimilar for factors of prepregnant weight and ponderal index. Table 8 presents the statistical data for anthropometrics within the grouping of the maternal sample.

The women who ate inadequately for protein and kilocalories during pregnancy actually began the pregnancy with a higher weight and ponderal index than the women who comprised the adequate diet group. This weight and ponderal index advantage in the inadequate

Table 5

Comparison of Previous Obstetrical History with Intake and Group Assignment

	Adequate Diet N=8		Inadequate Diet N=11		p Value	Experimental N=10		Control N=9		p Value	Total N=19(a)	
	N=19[a]					N=19						
	No.	%	No.	%		No.	%	No.	%		No.	%
Previous abortions												
Yes	4	50	4	36	NS[b]	5	50	3	33	NS	8	42
No	4	50	7	64	NS	5	50	6	67	NS	11	58
Previous stillbirths												
Yes	0	0	0	0	NS	0	0	0	0	NS	0	0
No	8	100	11	100	NS	10	100	9	100	NS	19	100
Previous maternal complications												
Yes	1	12	3	27	NS	2	20	2	22	NS	4	21
No	7	88	8	73	NS	8	80	7	78	NS	15	79
Previous newborn complications												
Yes	1	12	2	18	NS	3	30	0	0	NS	3	16
No	7	38	9	82	NS	7	70	9	100	NS	16	84
Previous birthweight 3000 grams												
Yes	1	12	5	45	NS	3	36	3	33	NS	6	32
No	7	88	6	55	NS	7	70	6	67	NS	13	68

Note. [a] N=19 due to missing data; [b] not significant α = .05 (2-tailed test).

Table 6

Comparison of Personal Health Hazards with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value	Total	
	N=28[a]					N=29					N=29	
	No.	%	No.	%		No.	%	No.	%		No.	%
Alcohol consumption												
None	11	85	14	93	NS[b]	12	86	14	93	NS	26	90
Rarely	2	15	1	48	NS	2	24	1	7	NS	3	10
Cigarette usage												
None	11	85	11	73	NS	13	93	10	65	NS	23	79
Yes	2	15	4	27	NS	1	7	5	35	NS	6	21

Note. [a]N=28 due to missing data; [b]not significant at α = .05 (2-tailed test).

Table 7

Comparison of Participation in WIC with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value	Total N=29	
	N=28[a]		—			N=29						
	No.	%	No.	%		No.	%	No.	%		No.	%
WIC												
Yes	2	15	4	27	NS[b]	2	14	5	33	NS	7	24
No	11	85	11	73		12	86	10	67		22	76

Note. [a] N=28 due to missing data; [b] not significant at α = .05 (2-tailed test).

Table 8

Comparison of Anthropometric Measures with Intake and Group Assignment

	Adequate Diet N=13			Inadequate Diet N=15			P Value	Experimental N=14			Control N=15			P Value	Total N=29		
	N=28 [a]							N=29									
	$\bar{x}$	SD	Range	$\bar{x}$	SD	Range		$\bar{x}$	SD	Range	$\bar{x}$	SD	Range		$\bar{x}$	SD	Range
Height in cm.	161.8	6.0	153-175	162.4	6.3	153-175	NS[b]	162.8	7.1	153-175	161.6	4.9	153-175	NS	162.1	6.0	153-175
Prepregnant weight in pounds	121.1	16.5	100-150	148.3	44.7	90-237	.048[c]	131.1	35.9	97-237	138.9	37.1	90-220	NS	135.1	36.1	90-237
Ponderal index (gm/cm^2)	21.6	3.0	18-28	25.4	6.4	18-36	.063[d]	22.3	4.5	17.8-35.2	24.6	5.9	17.6-36.1	NS	23.5	5.3	17.6-35.1
Ideal weight in pounds	122	13.1	108-151	130	16.9	101-163	NS	125.6	16.7	105-159	126.0	14.5	101-163	NS	125.9	15.4	101-163

Note. [a]N=28 due to missing data; [b]not significant at α = .05 (2-tailed test); [c]significant at α = .05 (2-tailed test); [d]suggestive of significance.

diet group did not translate to better infant outcomes. For example, even though individuals in the inadequate diet group had higher weights and ponderal indexes they produced smaller babies when compared to the infants born to women in the adequate group.

The question often arises that if a woman is heavier at the onset of pregnancy should she limit her prenatal weight gain? The findings of this initial research indicate no advantage to prenatal weight restriction in heavier women. Furthermore, this study indicates that weight restriction or eating inadequately may lead to an infant outcome of lower birthweight, an outcome linked with many problems in the neonatal period.

Hypotheses

Altogether there were nine out of the ten hypotheses that were tested. The tenth related to mortality and there was none. The sample size of $N=29$ limited the researcher in the sufficient testing of the hypotheses. It is recognized that a much larger sample size is needed for more definitive conclusions. Therefore, these data present preliminary information only.

All of the hypotheses are stated, presented in tabular form whenever possible, and test results or statistics are offered. Discussion of the results of testing follows with reference to the review of the literature when it seems appropriate. In some instances the testing showed interesting trends ($.05 \leq p .10$, two-tailed t test). These trends, although not significant at $\alpha = .05$ (two-tailed t test), are also presented as suggestive of significance.

Since this information could be useful in future phases of this research, these trends will be stated.

Hypothesis One

Hypothesis one stated:

> Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher birthweight infants than infants born to mothers whose intake was less than 85% of their prescription.

Viewed in total, the participants had a mean weight of 3,274.0 grams with a standard deviation of 362.7 grams. The median weight was 3,280 grams with a range from 2,500 grams to 4,020 grams. The skewness was .369 with a sample size of 29.

The birthweight mean of this study closely approximates the means found in the Montreal study. For the Higgins Montreal Diet Dispensary study the mean birthweight for infants born to women referred to the diet dispensary was 3,291 grams. Another study done in New York produced birthweights that were lower than in this study (Rush et al., 1980). In the New York study the supplemented group birthweight mean = 2,938 grams, the complement group birthweight mean = 3,011 grams, and the control group birthweight mean = 2,970 grams. The lower means of the New York study when compared to this study may be explained when one considers that the New York patients were deliberately selected as high nutritional risk patients while this study did not select for this factor. In fact, potential high risk participants were eliminated.

Did the intervention of the prescription diet of this study make a difference in the birthweight of the newborns? Examination of the

experimental group yielded a birthweight mean of 3,279 grams, an S.D. of 431.0 grams, and a median of 3,900 grams. The range included a span of 2,500 grams to 3,900 grams. The skewness = -.392. The controls projected a mean birthweight of 3,268.7 grams, and S.D. of 300.59 grams. The newborns ranged in weight from 2,950 to 4,020 grams. The skewness of the controls differed from the experimentals with the controls having a positive value of 0.904 which is a value close to 1.0.

The t-test shows a p-value which was not significant at $\alpha = .05$ (two-tailed test). Perhaps there were no significant differences between the experimental and control groups for several reasons including: sample size, compliance, or some other confounding variable.

The birthweight data were examined in relationship to the comparison groups of adequate versus inadequate diet groups.

Birthweight in the adequate diet group averaged 3,419.2 g versus 3,173.6 g in the inadequate diet group. This 245.6 g average difference was suggestive of statistical significance (two-sided p = .07). Power calculations indicated that a Type II Error may have occurred here due to small sample size: the study's sample size had 90% power to detect differences of only 447.3 g or more, although a difference of 270.4 g or more would have been statistically significant at $\alpha = .05$ if it had been observed. This variable is also somewhat unreliable because it does not control for gestational age.

Table 9 contains the data related to hypothesis one. The women who ate according to their individual prescription all had consumed greater than or equal to 85% of both protein and kilocalories when

Table 9

Comparison of Infant Birthweight with Intake and Group Assignment

Outcomes	Adequate Diet N=13			Inadequate Diet N=15			p values
	$\bar{x}$	SD	Range	$\bar{x}$	SD	Range	
Birthweight in grams	3,419.2	395.1	2,500-4,020	3,173.6	309.7	2,550-3,941	.07[b]

[a] (N=28)

Outcomes	Controls			Experimentals			p values
Birthweight in grams	3,269	301	2,950-4,020	3,280	431	2,500-3,900	NS[c]

[a] (N=29)

Note. [a] N=28 due to missing data; [b] Type II Error probably occurred due to small sample size.

[c] not significant at α = .05 (2-tailed test).

protein and kilocalories were computed on an average daily basis after 20 weeks of gestation. Thirteen women met these criteria while 15 women failed to meet their prescriptions.

The birthweight data were handled in a more powerful way than simply looking at the grams in weight for infants regardless of weeks of gestation. There are tables and graphs available which allow the designation of actual percentiles for weight based on differentiation according to sex and weeks of gestation. Thus, a male infant who weighs 3,175 grams and has a gestational age of 40 weeks can be classified as being in the 40th percentile for weight. The group birthweight percentile mean for infants born to women who ate adequately for protein and kilocalories was 69, while the inadequate intake group had a mean of 50. The p-value equaled .03 in favor of the adequate diet. Table 10 presents the statistics for birthweight percentile for all groups of women. Thus, it can be concluded that adequate diet as measured by the Higgins method significantly increases infant birthweight, controlling for sex and gestational age.

Hypothesis Two

Hypothesis two stated:

> Infants born to mothers who have a nutritional intake of protein and kilocalories equal to or greater than 85% of their individual prescription will have decreased mortality compared to infants born to mothers who did not eat according to their individual prescription.

Hypothesis two could not be tested since there were no infant deaths attributed to women in the study. There was one fetal demise born to a women who was initially in the study, but disqualified when

Table 10

Comparison of Birthweight Percentile with Intake and Group Assignment

	Adequate Diet N=13 (N=28[a])	Inadequate Diet N=15	p Value	Experimental N=14 (N=29)	Control N=15	p Value
Outcomes						
x %	69%	50	.03[b]	57	57	NS[c]
SD	24	20		26	23	
Range	5-91%	22-91%		5-91%	19-96%	

Note. [a] N=28 due to missing data; [b] significant at α=.05 (2-tailed test); [c] not significant at α = .05 (2-tailed test).

it was learned that she had long standing hypertension.

Hypothesis Three

Hypothesis three stated:

> Infants born to mothers who have a nutritional intake of protein and kilocalories equal to or greater than 85% of their individual prescription will have decreased morbidity compared to infants born to mothers whose intake was less than 85% of their individual prescription.

Hypothesis three could not be supported. There was no significant difference in morbidity between any of the groups of infants.

Morbidity was determined to be any infant physical problem whether structural or functional. The components of the morbidity classification included structural or functional problems delineated from the physical examination, respiratory complications, problems related to increased bilirubin blood levels, and clinical estimations of gestational age that were abnormal. Structural problems related to the physical examination were listed and also categorized in a nominal sense. The nominal treatment of structural problems divided infants into two groups. One group represented normal infants or infants who had no structural problems. The other group of infants had one or more structural problems.

Table 11 lists the actual structural problems discovered in the infants born to women in the study. The problems included a hydrocele, hip clicks, a chordee, and cyanosis. The problems that occurred, occur in the general population. In Table 12 is the breakdown of the structural problems according to the groups of women who did or did not eat to their prescriptions at equal to or greater than the 85% for both protein and kilocalories computed on an average

Table 11

Structural Problems Versus Cases

Outcomes	Case #
Hydrocele	9
Chordee	11
Hip click	17, 29
Cyanosis	7, 20, 27

Table 12

Physical Examination Findings, Structural Nominal Compared with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value
	N=28[a]					N=29				
	No.	%	No.	%		No.	%	No.	%	
Outcomes										
None	8	62	12	86	NS[b]	10	77	11	73	NS
One or more	5	38	2	14		3	23	4	27	

Note. [a] N=28 due to missing data; [b] not significant at α = .05 (2-tailed test).

daily basis. Seven out of 29 cases had structural problems. This represented 24% of the sample that was affected with either minor or more serious problems. Also structural problems are presented for the experimental and control groups.

Functional problems determined during the physical examination were treated in the same way as the structural problems. Functional problems were analyzed for mothers who complied with their prescriptions and women who did not comply with their prescriptions. Functional problems were listed in one variable by actual number of problems and in another variable in a nominal sense. In the nominal sense infants who had no problems were considered normal while infants with one or more problems were considered abnormal.

The only functional problems discovered were: breathing difficulty, tremors, jerky movements, a murmur, an elevated hematocrit requiring reduction of blood, and edema. The results of testing functional problems compared to all groups of mothers can be found in Table 13.

Respiratory complications were considered part of the morbidity issue. There was no significant difference between groups for respiratory complications. (Table 14). The actual respiratory complications found were: infants needing resuscitation briefly in the delivery room only, infants requiring respiratory resuscitation and continuous positive air pressure (CPAP) in the delivery room or for a brief amount of time, and infants requiring oxygen therapy for 24 hours or more.

Normal infants were infants not requiring any ventilation assis-

Table 13

Functional Abnormalities Compared with Intake and Group Assignment

	Adequate Diet N=13	Inadequate Diet N=15	p Value	Experimental N=14	Control N=15	p Value
	(N=28[a])			(N=29)		
Functional Problems						
$\bar{x}$	1.0	.71	NS[b]	1.1	.60	NS
SD	1.4	1.5		1.8	1.1	
Range	0-4	0-5		0-5	0-3	

Note. [a] N=28 due to missing data; [b] not significant at α=.05 (2-tailed test).

Table 14

Comparison of Respiratory Complications with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value
	N=28[a]					N=29				
	No.	%	No.	%		No.	%	No.	%	
Respiratory complications None	9	69	11	73	NS[b]	11	79	10	66	NS
Resuscitation in delivery room	2	15	1	7	NS	0	0	3	20	NS
Resuscitation in delivery room and CPAP	1	8	0	0	NS	0	0	1	7	NS
Oxygen in first 24 hours	0	0	1	7	NS	1	7	0	0	NS
Oxygen beyond first 24 hours	1	8	2	13	NS	2	14	1	7	NS

Note. [a] N=28 due to missing data; [b] not significant at α = .05 (2-tail test).

tance. Table 15 deals with these data by comparing respiratory complications between women who did or did not eat to prescription after 20 weeks gestation. There was no significant difference between groups. There was a mean difference between groups for respiratory complications of .0934 in favor of the adequate diet group.

Bilirubin abnormalities constituted a component of the morbidity classification. There was no significant difference between groups for bilirubin problems. The bilirubin abnormality category was broken down into the following designations: no jaundice detected, jaundice detected, however, no treatment necessary, and jaundice detected and treatment given to the infant. Table 16 presents this information when the adequate and inadequate, experimental and control groups were considered. There was no difference in gestational age between groups (Table 17).

Hypothesis Four

Hypothesis four stated:

> Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will score more positively on the Early Infant Relationship behavioral characteristic scale by Barnard et al. (1978) than infants born to mothers whose intake was less than 85% of their individual prescription.

Hypothesis four was not supported by the data. There was no significant difference between groups when the total score was computed for the behavioral test.

The behavior test had eight parts: alertness, both auditory and visual, habituation, cuddliness, consolability, motor behavior and activity, irritability, readability, and smiling. The eight parts

Table 15

Comparison of Respiratory Complications (None or Present) with Intake and Group Assessment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value
	N=28[a]					N=29				
	No.	%	No.	%		No.	%	No.	%	
Respiratory complications										
None	9	69	11	73	NS[b]	11	79	10	66	NS
Present (one or more)	4	31	4	27		3	21	5	34	

Note. [a] N=28 due to missing data; [b] not significant at α =.05 (2-tailed test).

Table 16

Comparison of Jaundice and Bilirubin Complications with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		Experimental N=14		Control N=15	
	N=28[a]				N=29			
Outcomes	No.	%	No.	%	No.	%	No.	%
No jaundice (as determined by physical examination)	13	100	13	87	12	86	14	93
Some jaundice (as determined by physical examination)	0	0	0	0	0	0	1	7
Jaundice present (as determined from chart review)	0	0	2	13	2	14	0	0

Note. [a] N=28 due to missing data.

Table 17

Comparison of Gestational Age with Intake and Group Assignment

	Adequate Diet N=13			Inadequate Diet N=15			p Value	Experimental N=14			Control N=15			p Value	Total		
	N=28[a]							N=29									
	$\bar{X}$	SD	Range	$\bar{X}$	SD	Range		$\bar{X}$	SD	Range	$\bar{X}$	SD	Range		$\bar{X}$	SD	Range
Clinical estimation of weeks gestation at time of delivery	39	1.43	36.5-41	39	1.5	37-42	NS[b]	39	1.6	36.5-42	39	1.4	37-41	NS	39	1.4	36-42

Note. [a] N=28 due to missing data; [b] not significant at α = .05 (2-tailed test).

were scored individually so that the higher the score the more desirable the behavior. The best score possible was 100%. When all infants were considered, the mean score was 69%. Infants born to women who did not eat to prescription had a mean score of 70%, while infants born to women who did eat to prescription scored slightly less with a mean score of 67%. There was, however, no statistical significance between these groups (Table 18).

Hypothesis Five

Hypothesis five stated:

> Infants born to mothers who have nutritional intakes of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher ponderal indexes when compared to infants born to mothers whose intake was less than 85% of their individual prescription.

Hypothesis five was not supported by the data. There was a difference between the adequate and inadequate diet groups for ponderal indexes. The total sample had a mean ponderal index of 2.4 which was above the 2.39 level considered to be the normal value. The infants born to women with adequate diets had a greater or slightly better mean ponderal index of 2.47 compared to the other group of babies born to mothers who had a mean ponderal index of 2.30. This is a clinically significant low level for the inadequate group.

The .1649 average difference was suggestive of statistical significance (two-sided, $p = .058$). Power calculations indicate that a Type II Error may have occurred due to small sample size: the study's sample size had 90% power to detect differences of only .279 or more, although a difference of .169 or more would have been statistically significant at $\alpha = .05$ if it had been observed (Table 19).

Table 18

Comparison of Infant Behavior Test Total Score (Percent)

with Intake and Group Assignment

	$\bar{x}$	SD	Range	N=	p Value
Adequate diet	57	23	0-85	13	NS[b]
Inadequate diet (N=28[a])	57	27	0-88	15	NS
Experimental	55	30	0-88	14	NS
Control (N=29)	60	20	0-80	15	NS

Note. [a]N=28 due to missing data; [b]not significant at α = .05 (2-tailed test).

Table 19

Comparison of Infant Ponderal Index with Intake and Group Assignment

	Adequate Diet N=13	Inadequate Diet N=15	p Value	Experimental N=14	Control N=15	p Value
	(N=28[a])			(N=29)		
Ponderal index						
$\bar{x}$	2.47	2.30		2.34	2.40	NS[c]
SD	.22	.22	.058[b]	.21	.25	
Range	2.0-2.8	1.9-2.6		1.9-2.7	2.0-2.8	

Note. [a] N=28 due to missing data; [b] suggestive of significance; [c] not significant at α .05 (2-tailed test).

Women who ate adequately prenatally for protein and kilocalories subsequently delivered infants with better ponderal indexes. This was an important finding. Ponderal index, or the ratio of birthweight to body length, has been shown to be an indicator of fetal nutrition which is free of the confounding variables of race, sex, fetal age, and parity. The newborns who were born to women who ate adequately were, in fact, better nourished as indicated by their higher ponderal indexes.

When the category of ponderal index was divided into normal and abnormal designations of greater or less than the standard of 2.39 and tested between groups, no statistically significant difference was discovered between any group. Table 20 presents this information.

Hypothesis Six

Hypothesis six stated:

> Infants born to mothers who have nutritional intake of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher hematocrit laboratory values when compared to infants born to women whose intake was less than 85% of their individual prescription.

Hypothesis six was not supported by the data. There was no significant difference between groups for hematocrit blood levels. The mean venous hematocrit difference between groups was 3.4% in favor of the infants born to women who ate to prescription. The mean difference between groups for the capillary hematocrit level was 2.8%, again in favor of the infants born to women who ate to prescription.

The capillary hematocrit mean for the met prescription group was 60 while the other groups mean was 57. Normal levels for capillary

Table 20

Comparison of Infant Ponderal Index Divided with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value
	N=28[a]					N=29				
	No.	%	No.	%		No.	%	No.	%	
Ponderal index										
Normal or greater than 2.39	7	54	6	40	NS[b]	6	43	7	47	NS
Less than 2.39	6	46	9	60		8	57	8	53	

Note. [a] N=28 due to missing data; [b] not significant α = .05 (2-tailed test).

hematocrit are 50-70 (Eggert, L.D., M.D. Personal communication, March 15, 1984). The adequate diet group had a mean venous hematocrit level of 58, while the inadequate diet group had a mean value of 55. Normal levels for the venous hematocrit are 45-65 (Eggert). Table 21 illustrates this information.

Hypothesis Seven

Hypothesis seven stated:

> Infants born to mothers who have nutritional intake of protein and kilocalories greater than or equal to 85% of their individual prescription will have higher dextrostix values when compared to infants born to women whose intake was less than 85% of their individual prescription.

Hypothesis seven was not supported by the data. There was not a statistically significant difference between groups for dextrostix values. The mean difference between groups was 7 mg/dl in favor of the group of women who ate greater than or equal to 85% of both their protein and kilocalories after 20 weeks of gestation. Table 22 presents this information.

Dextrostix values in newborns can be grouped into normal (45 mg % - 110 mg %) and abnormal (less than 45 mg %) categories (Eggert, L.D., M.D., Personal communication, March 15, 1984). There was no statistically significant difference between any group when the data were analyzed in this manner. However, as Table 23 shows none of the infants born to women in the adequate diet group had dextrostix values less than 45 mg/dl but three infants in the inadequate diet group had dextrostix values less than 45 mg/dl.

Table 21

Comparison of Venous and Capillary (or heelstick) Hematocrit Levels with Intake and Group Assignment

Hematocrit	Adequate Diet N=28[a]	Inadequate Diet	p Value	Experimental N=29	Control	p Value	Total
Capillary							
$\bar{x}$	60	57	NS[b]	57	60	NS	58
SD	7.4	9.5		10.4	5.8		8.4
Range	48-70	32-68		32-70	50-68		32-70
N=	4	9		11	11		22
Venous							
$\bar{x}$	58	55	NS	58	56	NS	56
SD	7.2	9.3		4.6	9.9		8.2
Range	52-70	37-63		53-63	37-70		37-70
N=	8	9		4	7		11

Note. [a]N=28 due to missing data; [b]not significant at α = .05 (2-tailed test).

Table 22

Comparison of Dextrostix mg/dl with Intake and Group Assignment

	Adequate Diet N=13 (N=28[a])	Inadequate Diet N=15	p Value	Experimental N=14 (N=29)	Control N=15	p Value
$\bar{x}$	60	53	NS[b]	56	58	NS
SD	15	18		17	16	
Range	45-92	25-90		25-90	30-92	

Note. [a] N=28 due to missing data; [b] not significant at α = .05 (2-tailed test).

Table 23

Normal and Abnormal Dextrostix mg/dl Values Compared with Intake and Group Assignment

	Adequate Diet N=13		Inadequate Diet N=15		p Value	Experimental N=14		Control N=15		p Value
	N=28[a]					N=29				
	No.	%	No.	%		No.	%	No.	%	
Dextrostix values										
less than 45 mg/dl	0	0	3	20	NS[b]	1	7	2	13	NS
45-100 mg/dl	13	100	11	73		13	93	12	80	
missing cases										

Note. [a] N=28 due to missing data; [b] not significant at α=.05 (2-tailed test).

Hypothesis Eight

Hypothesis eight stated:

> Infants born to mothers who have a nutritional intake of protein and kilocalories greater than or equal to their individual prescription will have greater skin fold measurements than infants born to women who did not eat according to their individual prescription.

Hypothesis eight was not supported. The mean difference between groups for arm muscle diameter percentile was 5%, $p = .11$ (two-tailed t test). The mean muscle diameter percentile for infants born to women with adequate nutritional intake was 17% while the inadequate group result was 12%. Women who ate adequately for both protein and kilocalories seem to deliver infants with larger arm muscle diameters than women who did not eat adequately. Table 24 presents these data. There was no statistically significant difference in skin fold measures between the experimental and control groups.

It is interesting to note that both groups of infants had a mean percentile for arm muscle diameter that was on the low side. Since the tables for arm muscle diameter percentiles are made using a sample of infants age birth to 4 months, and since all of the infants in our study were measured in the first 48 hours, our sample was expected to fall in the lower percentiles for mean arm muscle diameter. Very little information concerning the statistics for infant skin fold measurements is available. For example, there were no percentile tables for the subscapular skin fold values for infants in the first 4 months of life. Because of the lack of data for newborn

Table 24

Arm Muscle Diameter Percentile Compared with Intake and Group Assignment

	Adequate Diet N=13	Inadequate Diet N=15	p Value	Experimental N=14	Control N=15	p Value	Total
	N=28[a]			N=29			
$\bar{x}$	17	12	.1	14	12	NS[b]	14
SD	9	6		10	6		7.6
Range	4-32	5-24		5-32	4-24		4-32

Note. [a]N=28 due to missing data; [b]not significant at α=.05 (2-tailed test).

subscapular skin fold values and norms, this measurement, the subscapular skin fold measurements of the sample, could not be analyzed completely.

Perhaps this study can provide some data in this area. Listed in Table 25 are the subscapular measurements for our sample. Our sample represented newborns born to women who were all relatively well nourished.

The actual mean subscapular values ranged from 3.0 - 7.0 for the entire sample. A proposed table was calculated based on the subscapular values drawn from this study.

No table of this kind could be found in the literature. Well nourished infants in this country have no standard tables for subscapular skin fold values and because of this it is difficult to estimate fat percentages in this population. This study was replicated and the subscapular skin fold values of the expanded sample will be incorporated into a new table of skin fold standards (La Malfa, T., Ryan, B. & Egger, M., Personal communication, May 1984). By further increasing the sample with further newborn skin fold testing and by incorporating the results into a new table, it is hoped that researchers in the future will have the ability to contrast subscapular skin fold measurements with normal standard values for newborns. This will enable researchers to better assess nutritional status in newborns.

Table 25

Subscapular Mean Values

	Percentiles (mm)				
	5th	15th	50th	85th	95th
Age					
1-2 days (males or females)	3.75	3.9	4.7	5.7	6.7

Hypothesis Nine

Hypothesis nine stated:

> Infants born to mothers who have a nutritional intake of protein and kilocalories greater than or equal to their individual prescription will have more positive results in their physical examinations than infants born to women who did not eat according to their individual prescription.

Hypothesis nine was not supported by this study. There was no difference in means between groups for vital signs or anthropometric measurements as discovered during the physical examination.

There was no significant difference between groups for either heart rate or respiratory rate.

Hypothesis Ten

Hypothesis ten stated:

> Infants born to mothers who have nutritional intake of protein and kilocalories greater than their individual prescription will have higher Apgar scores than infants born to women who did not eat adequately.

Hypothesis ten was not supported. Five minute Apgar scores were suggestive of statistical significance between adequate and inadequate diets (two-sided $p = .058$). The average difference between groups was 0.5 points against the adequate diet, a clinically unimportant difference. Power calculations could not rule out the possibility of Type II Error. However, there is no evidence of such an error in the small observed difference between groups (Table 26).

Additional Findings

Some statistically significant differences between infant variables were discovered apart from the variables described in the hypotheses.

Table 26

Comparison of Five Minute Apgar Scores with Adequate and Inadequate Diet and Experimental and Control Groups

	Adequate Diet N=13	Inadequate Diet N=15	p Value	Experimental N=14	Control N=15	p Value
	N=28[a]			N=29		
Mean	8.3	8.8	.058[b]	8.4	8.5	NS[c]
SD	.75	.56		.65	.70	
Range	7-9	8-10		7-9	7-10	

Note. [a] N=28 due to missing data; [b] suggestive of significance; [c] not significant at $\alpha = .05$ (2-tailed test).

A correlation matrix test was performed on the variables in length of first and second stages of labor (in hours) and the variable of infant readability. Readability depends on ability of the infant to send consistent and clear messages to caregivers. This category of the behavioral test was scored in such a way that the higher the score the better was the readability of the newborn. A statistically significant relationship existed when these variables were compared (p = .05, two-tailed t test). The inverse relationship between these variables can be expressed by stating that the longer the first and second stages are continued the less readable would be the infant during the first 48 hours of testing.

This finding supports the contention that excessively long labors can interfere with an infant's ability to communicate needs, for example, warmth and food. The popular notion that infant-parent bonding must be initiated in the first hours of the newborn's life may not be appropriate for maternal infant units that have experienced prolonged periods of first and second stages of labor. Intense attempts for bonding in these cases might have better chances for success when both the infant and the parents are more rested and better able to communicate their needs. Table 27 presents these data.

Another component of the behavioral test, irritability, was positively correlated with weight in grams. It was found that the higher the birthweight the lesser was the irritbility (p = .02, two-tailed t test). Table 28 expresses the statistics for this relationship between weight and irritability. In scoring the category of irritability, babies who were least irritable received the highest or

Table 27

Correlation Between Length of First and Second Stages of Labor with Infant Readability

Length Stage 1&2 Hrs	Corr	Df	p(2-tail)
Readability	-.40853	21	.05275

Table 28

Correlation Between Birthweight and Irritability

Weight (Grams)	Corr	Df	p(2-Tail)
Irritability	.47512	22	.01896

best score.

Certainly a newborn who appears to be content or low in irritability will be easier to care for and more enjoyed by the parents. High irritability on the other hand is disturbing not only for the newborn but also for the parents. Irritability may even interfere with the bonding process that occurs between parents and infants. Many parents, for example, find it difficult to bond with an infant who cries most of the time. Good nutrition prenatally and the subsequent increase in infant birthweight may contribute to decreasing irritability, a desirable goal.

The 5 minute Apgar test was positively associated with four components of the behavioral test; readability, alertness, motor ability and habituation. The higher the 5 minute Apgar test scores were the better were the scores in readability (p [two-tailed test] = .05), alertness (p [two-tailed test] = .04), and motor quality and quantity (p [two-tailed test] = .02) and habituation (p [two-tailed test] = .01). See Table 29 for these statistics.

The significance of these correlations is that newborns who score well on their five minute Apgar test also have some optimal behavioral characteristics in their first 48 hours of life.

There was a positive correlation between infant dextrostix values and the behavioral component of habituation. In this study and with this sample it appeared that the higher the blood sugar value the better the infant was able to habituate. Habituation, or the ability of the newborn to dampen the effect of noxious environmental stimuli would seem to be compromised in infants with low

Table 29

Correlations Between Five Minute Apgar

and Behavioral Test Components

Apgar (Five Minute)	Corr	Df	p(2-Tail)
Readability	.3908	23	.05389
Alertness	.41546	23	.03889
Motor activity quantity and quality	.47768	24	.01359
Habituation	.53367	23	.00601

blood sugar values. Suggestion of significance was found with a p-value of .09597 (two-tailed) (Table 30).

When the variable described as infants with and without jaundice problems was compared with the variable defined as low birthweight versus normal birthweight infants, some interesting data were evidenced. The only infants in this study that had problems with jaundice were in the category of low birthweight or birthweights of less than 3,006 grams. None of the infants with birthweights greater than or equal to 3,006 grams suffered problems with jaundice. The testing of the jaundice problem variable against this low birthweight infant category revealed significance at $p = .01$ two-tail. Table 31 presents these data. No infant had hemolytic disease. The jaundice seen in the low birthweight infants was probably "physiologic" jaundice. This jaundice is caused by the immaturity and poor function of liver enzymes and it is prevalent in small newborns (Eggert, L.D., M.D. Personal communication, March 15, 1984).

Table 30

Correlation Between Infant Blood Sugar Levels and Habituation

Dextrostix Mg %	Corr	Df	p(2-Tail)
Habituation	.34786	22	.09597

Table 31

Comparison of Jaundice Problems with Low Birthweight versus Normal Birthweight

(N=29)

	Greater than 3,006 Grams		Less than 3,006 Grams		p Value
	No.	%	No.	%	
No jaundice	22	100	4	57	.01
Jaundice present	0	0	3	43	

Note. [a] significant at α=.01 (2-tailed test).

CHAPTER V

SUMMARY, CONCLUSIONS AND AND RECOMMENDATIONS

This nutrition study had a favorable impact on the women and newborns in the study. Maternal health researchers were able to increase the protein and kilocalories in the prenatal diets of the women who received the intervention of the nutritional counseling. This increase in protein was found to be statistically significant using a two-tailed test at the 5% significance level and is presented in Table 32 (Smith & Sweeney, 1983).

Counseling methods were perfected and streamlined. This resulted in an effective, concise, and detailed approach to prenatal nuritional counseling.

The newborn analysis was exhaustive not only for anthropometric values but also for behavioral and physical analysis. The total newborn evaluation was also streamlined into a workable yet complete and concise analysis. Important infant findings were that adequate maternal diet for protein and kilocalories according to the Montreal Diet Dispensary guidelines may have contributed to improved infant birthweights, and birthweight percentiles, ponderal indexes, and skin fold measures.

Problems in the study were the small sample size, a sample that

Table 32

Comparison of Prescription Ingestion for Entire Study Period

Between the Experimental and Control Groups

	Protein				Kilocalories			
	Experimental N=14	Control N=14	p Value	Total N=28	Experimental N=14	Control N=14	p Value	Total N=28
Actual average daily amount								
$\bar{x}$	93.7	82.8	.048[a]	88.2	2642.1	2406.3	.114	2524.2
SD	16.8	10.5		14.8	408.8	353.0		393.6
Range	66.8-120	65.3-102.1		65.3-120	2018.6-3340.6	2085.9-3327.3		2018.6-3340.6
Percent of prescription								
$\bar{x}$	95	83	.178[b]	89.3	92	83	.074[c]	87.7
SD	23.3	21.1		22.6	13.8	11.2		13.1
Range	59-154	54-116		54-154	66-124	68-108		66-124

Note. [a] significant at α = .05 (2-tailed test); [b] not significant at α = .05 (2-tailed test); [c] =suggestive of significance (Adapted from Smith & Sweeney, 1983).

represented only generally well-nourished caucasians, and a deficit in the literature for tables and values for newborns in the area of skin fold measures and ponderal indexes.

Recommendations for further research include several suggestions. Increasing the sample size in numbers is necessary. Broadening the representation of the sample to include all races, cultures, ages, and socioeconomic backgrounds is also recommended. The development of standards and tables for anthropometric data including skin fold information is also recommended based on sample size of greater than 1,000 newborns.

APPENDIX A

BIASED COIN DESIGN

Adaptive Randomization by Biased Coin Design

1. If this is the first subject, go to #3.

2a) Fill in numbers of subjects (n) in current table:

PRESCRIPTION DIET

	Less than 10 lb	Greater than or = 10 lb	Total
Underweight	n=	n=	
OK weight	n=	n=	
Total			

CONTROL DIET

	Less than 10 lb	Greater than or = 10 lb	Total
Underweight	n=	n=	
OK weight	n=	n=	
Total			

2b) In each table, circle the weight gain column and ideal weight row identifying the current subject to be randomized. Star (*) the weight gain total, the ideal weight total, and the cell that this subject would fall in, for each table.

2c) For each starred number, fill in t-values from the table below:

n	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
t(n)	1	4	10	15	20	24	27	30	33	36	38	40	42	44	46	47	48	49
n	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
t(n)	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	

2d) Calculate a score S(PD) for the prescription diet by multiplying together the 3 starred numbers in that table. Calculate a score S(C) for the control diet using the 3 starred numbers in the control table. Write the scores below:

S(PD) = _____ S(C) = _____

Biased Coin Design (Continued)

2e) Circle the smaller score and the diet corresponding to it. This is the preferred diet. If there is a tie, write TIE.

3a) Use the attached random number table. Close your eyes and point to a digit on the first page. Circle it below.

0 or 9 - Get a new digit

1 or 5 - Stay or p. 1 of the random number table

2 or 6 - Go to p. 2 of the random number table

3 or 7 - Go to p. 3 of the random number table

4 or 8 - Go to p. 4 of the random number table

3b) On that page, close your eyes and pick a 2-digit number (a 1-digit number plus the digit to its right). It tells what row the diet assignment will be in.

01 or 51 - use row 1

02 or 52 - use row 2

Your number	Row
_____	_____

10 or 60 - use row 10

20 or 70 - use row 20

30 or 80 - use row 30

40 or 90 - use row 40

50 or 00 - use row 50

3c) On the same page, close your eyes and pick another 2-digit number. If it is larger than 70, discard it and pick another. It tells exactly what column the first digit of the 2-digit diet assignment will be in.

Column

3d) If this is the first subject to be randomized, or if there was a tie for preferred diet, go to 3e. Otherwise, write down the 2-digit number starting in the row and column you found above.

_____.

Biased Coin Design (Continued)

If the number was 0 - 74 - assign the preferred diet.

If the number was 75 - 99 - assign the other diet. Now go to #4.

3e) If this is the first subject, or there was a tie for preferred diet, write down the 2-digit number starting in the row and column you determined in 3b and c. _____.

If even - assign the prescription diet.

If odd - assign the control diet.

4. Call the co-investigator to inform her of the new assignment. Write the updated assignment table on the randomization form, in the space available for the next subject.

Adapted from Efron, 1980.

Biased Coin Design (Continued)

1. Old Subjects

PRESCRIPTION

	LT 10	GTE 10	Total
Underwt.	n=	n=	n=
OK wt.	n=	n=	n=
Total	n=	n=	n=

CONTROL

	LT 10	GTE 10	Total
Underwt.	n=	n=	n=
OK wt.	n=	n=	n=
Total	n=	n=	n=

2. S(PRESCRIPTION DIET)

____ x ____ x ____

= ____

2. S(CONTROL DIET)

____ x ____ x ____

= ____

3a
0.9
1.5
2.6
3.7
4.8

3b-e
Your #
Row
3c Column
3d/e Number

Diet

4

Call to co-I

Date _____

Time _____

---

1. Old Subjects

PRESCRIPTION

	LT 10	GTE 10	Total
Underwt.	n=	n=	n=
OK wt.	n=	n=	n=
Total	n=	n=	n=

2. S(PRESCRIPTION DIET)

____ x ____ x ____

= ____

3a
0.9
1.5
2.6

3b-3
Your #
Row

4

Call to co-I

Date _____

Time _____

Biased Coin Design (Continued)

CONTROL

	LT 10	GTE 10	Total
Underwt.	n=	n=	n=
OK wt.	n=	n=	n=
Total	n=	n=	n=

2. S(CONTROL DIET)

____ x ____ x ____

= ____

3.7

4.8

3c Column	
3d/e Number	Diet

---

1. Old Subjects

PRESCRIPTION

	LT 10	GTE 10	Total
Underwt.	n=	n=	n=
OK wt.	n=	n=	n=
Total	n=	n=	n=

2. S(PRESCRIPTION DIET)

____ x ____ x ____

= ____

3a	3b-3	4
0.9	Your #	Call to co-I
1.5		Date _____
2.6	Row	Time _____

CONTROL

	LT 10	GTE 10	Total
Underwt.	n=	n=	n=
OK wt.	n=	n=	n=
Total	n=	n=	n=

2. S(CONTROL DIET)

____ x ____ x ____

= ____

3.7

4.8

3c Column	
3d/e Number	Diet

APPENDIX B

ARM DIAMETER AND UPPER ARM CIRCUMFERENCE

TABLES

Percentiles for upper arm diameter and upper arm circumference for whites of the Ten-State Nutrition Survey of 1968-1970

Age midpoint years(a)	Arm muscle diameter percentiles, mm					Arm muscle circumference percentiles, mm				
	5th	15th	50th	85th	95th	5th	15th	50th	85th	95th
Males										
0.3	26	30	34	40	42	81	94	106	125	133
1	32	34	39	44	46	100	108	123	137	146
2	35	37	40	44	46	111	117	127	138	146
3	36	38	42	46	48	114	121	132	145	152
4	38	39	43	48	50	118	124	135	151	157
6	40	43	47	51	53	127	134	146	159	167
7	41	43	48	52	55	130	137	151	164	173
8	44	46	50	55	59	138	144	158	174	185
9	44	46	51	58	64	138	143	161	182	200
10	45	48	53	59	64	142	152	168	186	202
11	48	50	55	62	67	150	158	174	194	211
12	49	52	58	66	70	153	163	181	207	221
13	51	54	62	71	77	159	169	195	224	242
14	53	58	67	74	84	167	182	211	234	265
15	55	59	70	80	86	173	185	220	252	271
16	59	65	73	83	89	186	205	229	260	281
17	66	69	78	86	92	206	217	245	271	281
21	69	74	82	91	97	217	232	258	286	305
30	70	77	86	94	100	220	241	270	295	315
40	71	76	86	96	101	222	239	270	300	318
Females										
0.3	27	29	33	37	40	86	92	104	115	126
1	31	32	37	41	43	97	102	117	128	135
2	34	36	40	44	46	105	112	125	140	146
3	34	37	41	44	46	108	116	128	138	143
4	36	38	42	46	48	114	120	132	146	152
5	38	40	44	48	51	119	124	138	151	160
6	38	41	45	49	53	121	129	140	155	165
7	39	42	47	52	56	123	132	146	162	175
8	41	44	48	53	59	129	138	151	168	186
9	43	45	50	56	62	136	143	157	176	193
10	44	47	52	58	62	139	147	163	182	186
11	44	48	55	62	67	140	152	171	195	209
12	48	51	57	64	68	150	161	179	200	212
13	49	53	59	66	71	155	165	185	206	225
14	53	56	61	70	74	166	175	193	221	234
15	52	55	62	70	74	163	173	195	220	232
16	54	57	64	72	83	171	178	200	227	260
17	54	56	62	71	77	171	177	196	223	241
21	54	58	65	73	80	170	183	205	229	253

Age midpoint years(a)	Arm muscle Diameter Percentiles, mm					Arm muscle Circumference Percentiles, mm				
	5th	15th	50th	85th	95th	5th	15th	50th	85th	95th
30	56	60	68	78	87	177	189	213	245	272
40	57	61	69	80	89	180	192	216	250	279

(a) The age group n are the same as in Table 1. Adapted from Frisancho, A. (1974). The American Journal of Clinical Nutrition 27, 1052-1058.

APPENDIX C

INFANT BEHAVIOR ASSESSMENT RECORD

Infant's Name_____ Birth Date _____

Gestational Age _____ Birth Time _____

Unusual Circumstances Surrounding Labor and Delivery ___

_____

_____

DIRECTIONS: Read this entire record before proceeding. To assess each behavior follow the procedures described.

I. Alertness (Alerting Behavior)

A. Visual Response to Face (State: quiet alert)

1. Employ strategies such as placing the infant in an upright position, talking continuously in a soft voice, unwrapping the infant, etc., to bring the infant to a quiet alert state to obtain an optimal response.
2. Pick up and hold the infant in front of and facing you about 7-8 inches away from your face.
3. Note when the infant's eyes focus on you. Then move your head slowly, alternating from side to side and up and down until the infant ceases to pay attention. You may need to repeat this if the infant loses focus at first.

Assess visual response to face by checking the description that best fits the infant observed. Always rate the infant on the best behavior.

____ can't determine
____ doesn't pay much attention
____ looks and follows, with eyes
____ looks and follows with eyes by turning head

Observation: Date_____ Time _____
Time of Last Feeding _____

B. Auditory Response to Voice (State: quiet alert, active alert)

1. Employ strategies to bring the infant to a quiet alert or active alert state.
2. With one hand under the infant's head and one under the buttocks, hold the infant face up, parallel to the floor, at shoulder level, about 6-8 inches away from your body.
3. Speak continuously to the infant and watch for:
   a. stilling of the infant's body
   b. widening and brightening of the eyes
   c. movement of the eyes toward you,
   d. turning of the head toward you.
4. Turn the infant around, face up, with the other side of the infant's head toward you. Speak continuously to

the infant and watch for the same reactions described above.

Assess response to voice by checking the description that best fits the infant observed. Always rate the infant on the best behavior.

____ can't determine
____ doesn't pay much attention
____ brightens and quiets to voice, moves eyes toward sound.
____ brightens and quiets to voice, turns head toward sound.

Observation: Date _____ Time _____
Time of Last Feeding: _____

C. Visual and Auditory Response to Face and Voice (State: quiet alert, active alert)

1. Employ strategies to bring the infant to a quiet or active alert state.
2. Pick up and hold the infant in front of and facing you at midline about 7-8 inches away from your face.
3. Begin talking and note when the infant begins to focus on your face. (Usually, the infant will decrease activity and widen the eyes.) Move your head slowly from side to side, up and down, talking continuously until the infant ceases to pay attention. You may need to do this several times if the infant loses focus.

Assess response to face and voice by checking the description that best fits the infant observed. Always rate the infant on the best behavior.

____ can't determine
____ doesn't pay attention
____ looks and follows with eyes
____ looks and follows with eyes by turning head to voice

Observation: Date _____ Time _____
Time of Last Feeding _____

II. HABITUATION (State: deep sleep, light sleep, drowsy)

A. Hold a rattle about 12 inches from the infant's ear while asleep or drowsy in the bassinette.
B. Shake rattle once.
C. Note the infant's response to the sound (eye blink, startle, facial or body movement).
D. Wait until this response has stopped. Then present the stimulus again until:

____ the infant no longer responds, or
____ the infant only blinks, or
____ you have presented the stimulus 10 times

Assess the habituation response by checking the description that best fits the infant observed. Always rate the infant on the best behavior.

____ can't determine
____ no response to stimuli
____ response diminishes or infant retains mild eye
____ blinks within five presentations of stimuli
____ responds to all 10 presentations of stimuli

Observation: Date _____ Time _____
Time of Last Feeding: _____

III. CUDDLINESS (State: quiet alert, active alert)

A. Employ strategies to bring the infant to a quiet or active alert state.

B. Hold the infant cradled in your arms and up on your shoulder.

C. Note whether the infant snuggles, relaxes, molds, nestles, resists, or is indifferent.

Assess response to cuddling by checking the description that best fits the infant being observed. Rate the infant on the best behavior.

____ can't determine.
____ not very cuddly, resists being held.
____ somewhat cuddly, eventually snuggles and relaxes
____ when held
____ very cuddly, immediately snuggles and relaxes when
____ held

Observation: Date _____ Time _____
Time of Last Feeding: _____

IV. CONSOLABILITY (State: crying for 15 seconds or longer)

A. Self-Consoling.

Note with a check mark self-consoling activities initiated within 15 serconds after crying begins.

____ sucks on fingers or fist.
____ sucks on tongue.
____ brings the hand to the mouth area.
____ roots.
____ pays attention to sounds.
____ pays visual attention to objects or faces.
____ changes in position.

Assess how the infant self-consoles by checking the description that best fits the infant observed.

____ can't determine
____ seldom tries to self-console
____ tries to self-console and sometimes succeeds briefly
____ frequently tries and succeeds in self-consoling

Observation: Date _____ Time _____
Time of Last Feeding: _____

B. Consoling by Caregivers
1. Lean over the infant and talk continuously. If unsuccessful,
2. place your hand on the infant's abdomen, holding the arms against the chest. If unsuccessful,
3. pick up and hold the infant in your arms. If unsuccessful,
4. hold and rock the infant. If unsuccessful,
5. give the infant a pacifier or feed the infant.

Assess how the infant is consoled by caregivers by checking the description that best fits the infant observed. Rate the infant on the best behavior.

____ can't determine
____ generally difficult to quiet.
____ usually quiets with touch or holding.
____ easily consoled, usually quiets to voice.

Observation: Date _____ Time _____
Time of Last Feeding: _____

V. MOTOR BEHAVIOR AND ACTIVITY (State: quiet alert, active alert)

A. Motor Behavior
1. Employ strategies to bring the infant to a quiet alert or active alert state.
2. Observe the infant's movements in both quiet alert and active alert to determine if they are smooth and rhythmical, or jerky.
3. Observe the range of arm movement, such as bringing hands to the face.

Assess the quality of motor behavior by checking the description that best fits the infant observed.

____ can't determine
____ movements are jerky most of the time.
____ movements are smooth most of the time, may bring both hands to the face.

Observation: Date _____ Time _____
Time of Last Feeding _____

B. Activity
1. Employ strategies to bring the infant to a quiet alert or active alert state.
2. Observe the amount of spontaneous activity when the infant is left alone.
3. Observe the amount of activity the infant demonstrates in response to handling or stimulation.

4. Note the difference in the amount of activity the infant demonstrates with handling and stimulation, versus when left alone.

Assess the amount of activity by checking the description that best fits the infant observed.

____ usually moves only when touched or handled
____ balanced amounts of quiet periods and active periods when left alone.
____ brief, quiet periods with longer, active periods.

Observation: Date _____ Time _____
Time of Last Feeding: _____

VI. IRRITABILITY (State: From sleep or awake states to fussing or crying)

Note with a check mark if the infant becomes upset during the following:

____ uncovering.
____ undressing.
____ diapering.
____ changing position.
____ bathing.
____ hunger.

Assess irritability by checking the description that best fits the infant observed.

____ can't determine
____ usually gets upset; cries or fusses with most stimuli
____ rarely cries or fusses with stimuli
____ never gets upset

Observation: Date _____ Time _____
Time of Last Feeding: _____

VII. READABILITY (All states)

A. Note the cues the infant gives through motor behavior, looking, listening, and behavior patterns during all states.

B. Check the following items if you find them to be clear and/or consistent for this infant.

	Clear	Consistent
1. patterns of behavior in all states	_____	_____
2. response to pleasing external stimuli in alert states	_____	_____
3. response to disturbing external stimuli	_____	_____
4. response to disturbing internal stimuli	_____	_____

5. patterns of motor behavior and activity in awake states _____ _____

Assess readability by checking the description that best fits the infant observed. Rate the infant on the best behavior.

____ can't determine
____ rarely readable
____ sometimes readable
____ consistently readable

Observation: Date _____ Time _____
Time of Last Feeding: _____

VIII. SMILE (State: drowsy, quiet alert, active alert, light sleep)

A. Check the state(s) in which smiles occur.
____ light sleep
____ drowsy
____ quiet alert
____ active alert

B. Note the frequency of smiles

Assess smile by checking the description that best fits the infant observed.

____ can't determine
____ not observed
____ observed occasionally
____ observed frequently

Observation: Date _____ Time _____
Time of Last Feeding: _____

From Buckner, 1983.

APPENDIX D

PROCEDURE FOR SKINFOLD MEASUREMENTS

1. Measure and mark the midpoint of the left arm (between the acromium process and the tip of the elbow) with the arm in a relaxed position across the abdomen. Use a flexible steel tape (Lufkin).

2. Measure the arm circumference at the midpoint of the arm using the Lufkin tape.

3. Apply the Lange caliper gauge just above the arm midpoint, wait three seconds, read and record the value. Repeat the procedure two more times.

4. Calculate the mean triceps skin fold measurement.

5. Calculate the tricep skin fold percentile. Interpolate percentiles from the Table.

6. Calculate the arm muscle diameter. The formula for this calculation is as follows:

$$\text{arm muscle diameter} = \frac{\text{arm circumference (mm)} - \text{tricep skin fold (mm)}}{\pi}$$

7. Using tables developed from whites of the Ten-State Nutrition Survey (1968-1970), calculate arm diameter percentile.

8. Calculate arm muscle circumference. The formula is:

$$\text{arm muscle circumference (mm)} = \text{arm circumference} - \pi\,(\text{triceps skin fold})$$

9. Calculate arm muscle circumference percentile.

10. Calculate arm muscle area; the formula is:

$$\text{arm muscle area } (\text{mm}^2) = \frac{\pi}{4}\,(\text{arm muscle diameter}^2)$$

11. Calculate the arm muscle area percentile (Frisancho, 1974).

12. Divide the following values: triceps skin fold mean percent, subscapular mean, arm circumference percent, arm muscle diameter percent, arm muscle circumference percent, and arm muscle area percent into categories of less than five percent or greater than or equal to five percent.

APPENDIX E

DETERMINING BLOOD GLUCOSE WITH THE DEXTROSTIX TEST

The proper technique includes obtaining a blood sample from the heel, cleansing the skin with 70% isopropyl alcohol, discarding the first drop of blood elicited, wiping the skin area with a dry sterile pledgt, eliciting an adequate second drop of blood, and using a machine for measuring blood glucose levels (Grazaitis & Sexson, 1980; Haworth, Dilling & Van Woert, 1972).

APPENDIX F

THE APGAR ASSESSMENT

Sign	Score		
	0	1	2
Heart rate	Absent	Slow (below 100)	Over 100
Respiratory effort	Absent	Weak, cry, hypoventi-lation	Good; strong cry
Muscle tone	Limp	Some flexion of extre-mities	Active motion, extremeities well flexed
Reflex irri-tability	No response	Grimace	Cry
Color	Blue, pale	Body pink, extremities blue	Completely pink

APPENDIX G

NEONATAL ASSESSMENT FORM

LDS HOSPITAL

NEONATAL ADMISSION AND ASSESSMENT

(Check or fill in as appropriate)

ADMISSION Date _____ Time _____

Weight _____ gms _____ lb _____ oz

Length _____ cm _____ inches

OFC _____ cm

Axilary temp _____

Heart rate _____

Respiratory rate _____

Breath sounds heard bilaterally ☐

Bowel sounds heard ☐

36 WEEKS	37 WEEKS	38-42 WEEKS
Hair Fine Wooly	Single Strands	Coarse
Ear Thin, No Cartilage	Returns Slowly	Ear Flips Back
Breast Tissue 2 mm	Breast Tissue 4 mm	Breast Tissue 7 mm
Testes High Few Rugae	Moderate Rugae	Full Rugae, Testes in Scrotum
Prominent Clitoris	Partially Covered	Labia Majora Covers Clitoris
Sole Creases ANT 1-3	Sole Creases ANT 2-3	Sole Creases Cover

Alcohol to cord ☐

Mucus trap _____ cc _____ Color

Erythromycin Ophthalmic instilled _____ time signature

Aqua mephyton IM 0.5 m.g. L/L thigh _____ time signature

Admit:

Color ☐ Pink
☐ Acrocyanosis

Tone: ☐ Normal

Cry: ☐ Normal

Wks. gest. by EDC _____

Clinical EGA _____ wks

☐ SGA ☐ AGA ☐ LGA

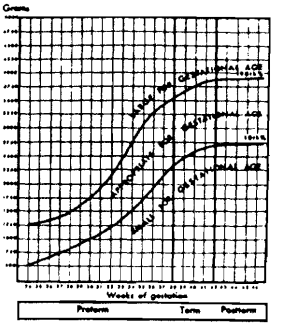
Dextrostix _____

Hematocrit _____

Radiant Heater ☐

Incubator ☐

Sierracin ☐



COMMENTS. _____

_____ Signature _____ ☐ Refer to Neonatal Clinical

NEONATAL ASSESSMENT AT _____

HEART _____ / min
☐ Murmur

RESPIRATIONS _____ / min
☐ Breath sounds normal
☐ Grunting
☐ Nasal flaring
☐ Retracting

SKIN
Condition
☐ Normal
☐ Dry
☐ Peeling
Color
☐ Normal
☐ Pale
☐ Plethoric
☐ Meconium stain
Cyanosis
☐ Absent/Acro
☐ Generalized
☐ Circumoral
Jaundice
☐ Absent
☐ Slight
☐ Moderate
☐ Severe

CRY
☐ Normal
☐ High pitched

HEAD
☐ Normal
☐ Molding
☐ Separated Sutures
☐ Cephalohematoma
☐ Caput
Fontanels
Anterior
☐ Normal size & tension
Posterior
☐ Normal size & tension

EYES
☐ Normal size/shape
☐ Red reflex seen

EARS
☐ Normal shape, size, position
☐ External canal patent

NOSE
☐ Patent nares

MOUTH
☐ Normal
☐ Cleft lip
☐ Cleft palate
☐ Excessive saliva

NECK
☐ Normal
☐ Masses
☐ Restricted ROM

ABDOMEN
☐ Normal
☐ Bowel sounds heard
☐ Hernia
☐ Masses

EXTREMITIES
☐ Normal
☐ Club foot
☐ Extra digits
☐ Hip click

FEMORAL PULSES
☐ Strong, equal bilateral
☐ Weak or asymmetrical
☐ Not felt

REFLEXES
Suck
☐ Strong
☐ Weak
☐ Absent
Palmer grasp
☐ Present bilateral
Planter grasp
☐ Present bilateral
Moro
☐ Present symmetrical
☐ Obtained with difficulty
☐ No response
☐ Asymmetrical

MOTOR ACTIVITY
☐ Normal
☐ Tremulous
☐ Jerky
☐ Asymmetrical

MUSCLE TONE
☐ Normal
☐ Hypotonic
☐ Hypertonic

GENITALIA
☐ Normal boy
☐ Normal girl
☐ Sex undetermined
☐ Hypospadias

ANUS
☐ Patent
☐ Imperforate anus

SPINE
☐ Straight and flat

COCCYX
☐ Normal
☐ Dimple
☐ Tuft of Hair

INJURIES
☐ Eccymosis
☐ Forcep marks

Clinical Impression ☐ Normal ☐ CNS Deficit ☐ Congenital Malformation ☐ Birth Injury

_____ Signature _____

Nur 199-74

APPENDIX H

CONSENT FORMS

Consent Form II

You have been randomly assigned to the experimental group of this nutrition study. This means that you will be given specific information about the protein and calories you individually require for a healthy pregnancy and outcome. In addition to this information, we will provide you with assistance in determining how to best meet your nutritional needs. If you are willing to receive this additional information and to attempt to eat the amount of foods determined according to your individual requirements, you will need to sign this consent form, which is in addition to Consent I which you signed earlier.

There are no known risks to following an individual food prescription for pregnancy. Several studies have indicated marked benefit to both mother and baby in reduced complications and increased health. There wil be no additional time required.

I understand that I will be given specific recommendations for nutrition based on my individual needs, and that I will receive this information during the visits in which I have already agreed to have my food intake assessed. I understand that participation in this study can be terminated at any time by withdrawing my consent without prejudice to my future care.

I have read the foregoing and my questions have been answered. I desire to participate in this study. I give permission for information gathered in this study to be released to the researchers named in Consent I.

_____
Signature of Patient

_____ _____
Date Witness

Consent

Upon consideration of the possible benefits and risks of the study as outlined, I approve the participation of my infant(s) in this study.

I give permission for information gathered in this study to be released to the researchers listed above.

_____
Signature

_____
Date

_____
Relationship

_____
Witness

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